Goto Session:
- UB01 Session 1
- UB02 Session 2
- UB03 Session 3
- UB04 Session 4
- UB05 Session 5
- UB06 Session 6
- UB07 Session 7
- UB08 Session 8
- UB09 Session 9
- UB10 Session 10
- UB11 Session 11
  - 1.1 Opening Session: Plenary, Awards Ceremony & Keynote Addresses
  - UB01 Session 1
  - 2.1 Executive Panel - New Opportunities in the Internet of Things
  - 2.2 Adaptability for Low Power Computing
  - 2.3 System Level Design Methods
  - 2.4 Automotive Systems and Smart Energy Systems
  - 2.5 Power of Assertions
  - 2.6 Design and Analysis of Dependable Systems
  - 2.7 Compilation and Code Transformations for Reconfigurable Computing
  - 2.8 Facilities for Design and Fabrication for FD-SOI IC
  - UB02 Session 2
  - 3.0 LUNCH TIME KEYNOTE SESSION: "How micro-electronic will change your life style" sponsored by Mentor Graphics
  - 3.1 Executive Panel - Extending Moore's Law & Heterogeneous Integration
  - 3.2 Passive Implementation Attacks and Countermeasures
  - 3.3 Loop Acceleration
  - 3.4 Tackling Memory Walls with Emerging Architectures and Technologies
  - 3.5 Breaking Simulation Boundaries
  - 3.6 Hot Topic - Memristor based Computation-in-Memory Architecture for Data-Intensive Applications
  - 3.7 Model-based Analysis and Verification
  - 3.8 Hot Topic - Design Methodologies for a Cyber-Physical Systems Approach to Personalized Medicine-on-a-Chip: Challenges and Opportunities
  - UB03 Session 3
  - IP1 Interactive Presentations
  - 4.1 Executive Panel - Trends and Challenges in Today's Automotive Semiconductors
  - 4.2 Implementation and Verification of Security Components
  - 4.3 Multi-/Manycore Scheduling
  - 4.4 Exploring Reliability and Efficiency Tradeoffs at the Architectural Level
  - 4.5 Industrial Test and Validation Experiments
  - 4.6 Online Testing and Reliable Memories
  - 4.7 How Resilient Are Emerging Technologies?
  - 4.8 Strength by Interdisciplinary Research: The Cadence Academic Network
  - UB04 Session 4
  - Exhibition-Reception Exhibition Reception
  - 5.1 SPECIAL DAY Hot Topic: Applications of IoT
  - 5.2 Hardware Trojan and Active Implementation Attacks
  - 5.3 Variability Challenges in Nanoscale Circuits
  - 5.4 Emerging Technologies for NoCs
  - 5.5 Critical Embedded Systems
  - 5.6 Analyzing and Improving Memories
  - 5.7 Architectures and Design for Cyber-Physical Systems
  - 5.8 Hot Topic - The Next Generation of Virtual Prototyping: Ultra-fast yet Accurate Simulation of HW/SW Systems
  - IP2 Interactive Presentations
  - UB05 Session 5
  - 6.1 SPECIAL DAY Hot Topic: Platforms for the IoT
  - 6.2 Physical Unclonable Functions
  - 6.3 Emerging Low Power Techniques
  - 6.4 Bridging the Moore's Law Gap with Application-Specific Architectures
  - 6.5 Multimedia and Consumer Electronics
  - 6.6 Panel - The Future of Electronics, Semiconductor, and Design in Europe
  - 6.7 Application-Mapping Strategies for Many-Cores
  - 6.8 Panel - The Future of Electronics, Semiconductor, and Design in Europe - > takes place as session 6.6 in Salle Bayard
  - UB06 Session 6
7.0 SPECIAL DAY Keynotes

UB07 Session 7
7.1 SPECIAL DAY Hot Topic: Design Tools for the IoT
7.2 Hot Topic - Trading Accuracy for Efficient Computing
7.3 Hot Topic - Advances in Hardware Trojans Detection
7.4 Routing Advances for Fault-tolerant and Multicast NoCs
7.5 System Reliability: from Runtime to Design Languages
7.6 Test Power and 3-D Fault Tolerance
7.7 Energy-efficient Computing
7.8 Critical Research Areas Driven by Industry Transformations
IP3 Interactive Presentations

UB08 Session 8
8.1 SPECIAL DAY Panel: Security and Verification for the IoT
8.2 Flash Memories & Numerical Approximation
8.3 Dynamic Thermal Management for Multi-cores
8.4 Industrial System Design Opportunities
8.5 Hot Topic - Spintronics based Computing
8.6 Statistical Answers to Analog/Mixed Signal Design and Test Problems
8.7 Compilers and Tools for Performance
8.8 Share a Fab - Multi Project Wafers Enable Your Innovations

Party DATE Party
9.1 SPECIAL DAY Hot Topic: Game-changing Innovative Technology Platforms for Health Care
9.2 Hot Topic - Transparent Use of Accelerators in Heterogeneous Computing Systems
9.3 NoC Optimization
9.4 Advanced Trends in Alternative Technologies
9.5 Modeling and Simulation of Extra-Functional Properties
9.6 Design, Synthesis and Validation of Analog Circuits
9.7 Test Generation, Fault Simulation and Diagnosis
9.8 Hot Topic - Monolithic 3D: A Path to Real 3D Integrated Chips

IP4 Interactive Presentations

UB09 Session 9
10.1 SPECIAL DAY Hot Topic: Wearable Medical Applications
10.2 Emerging Memory Architectures
10.3 Modern Architectures for Real-Time Systems
10.4 Energy Aware Data Center: Design and Management
10.5 Reconfigurable Architectures and Applications
10.6 Circuit Design and Test: From Characterization to Measurement
10.7 Expanding the Applicability of Formal Methods
10.8 From IP to EDA Tools Enterprise Management: What is so special?

UB10 Session 10
11.0 SPECIAL DAY Keynote
11.1 SPECIAL DAY Hot Topic: Implantable Medical Applications
11.2 Variability and Robustness for Emerging Technologies
11.3 Hot Topic - Multi/Many-Core Programming: Where Are We Standing?
11.4 Logic Synthesis: the Faithful, the Approximate and the Stochastic
11.5 Ultra-low Power Devices for Health and Rehabilitation
11.6 Video Architectures for Multimedia and Communications
11.7 Exploiting Dark Silicon
11.8 Exhibition Keynote - Designing Systems for the Connected Autonomous Future: An Industry Perspective

IP5 Interactive Presentations

UB11 Session 11
12.8 Tutorial: An Industry Approach to FPGA/ARM System Development and Verification
12.9 Interactive Presentations

UB01 Session 1
Date: Tuesday 15 March 2016
Time: 10:30 - 12:30
Location / Room:

<table>
<thead>
<tr>
<th>Label</th>
<th>Presentation Title Authors</th>
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UB02 Session 2
Date: Tuesday 15 March 2016
Time: 12:30 - 15:00
Location / Room:
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UB11 Session 11
Date: Thursday 17 March 2016
Time: 14:30 - 16:30
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## 1.1 Opening Session: Plenary, Awards Ceremony & Keynote Addresses

**Date:** Tuesday 10 March 2015  
**Time:** 08:30 - 10:30  
**Location / Room:** Auditorium Dauphiné

**Chair:**  
Wolfgang Nebel, University of Oldenburg, DE

**Co-Chair:**  
David Atienza, EPFL, CH

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<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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<td><strong>Speakers:</strong></td>
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<td></td>
<td></td>
<td>Wolfgang Nebel¹ and David Atienza²</td>
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<td>¹DATE 2015 General Chair, OFFIS, DE; ²DATE 2015 Program Chair, EPFL, CH</td>
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<td>1.1.3</td>
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<td><strong>Speaker:</strong></td>
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<td></td>
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<td>Geneviève Fioraso, secrétaire d’État chargée de l’Enseignement supérieur et de la Recherche (to be confirmed), FR</td>
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<td>Günther H. Oettinger, EU Commission, DE</td>
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<td><strong>KEYNOTE ADDRESS: ST TECHNOLOGIES FULLY ADDRESSING INTERNET OF THINGS APPLICATIONS FROM LP DIGITAL TO RF-CMOS, ENVM AND SENSORS</strong></td>
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<td><strong>Speaker:</strong></td>
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<td>Jean Marc Chery, STMicroelectronics, FR</td>
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**End of session**

Coffee Break in Exhibition Area

Coffee Break in Exhibition Area

On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area. **Lunch Break**

On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Ecrins (for fully registered conference delegates only).

**Tuesday, March 10, 2015**
Coffee Break 10:30 - 11:30

Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics

Coffee Break 16:00 - 17:00

**Wednesday, March 11, 2015**
Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)

Coffee Break 16:00 - 17:00

**Thursday, March 12, 2015**
Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00

UB01 Session 1
Date: Tuesday 10 March 2015  
Time: 10:30 - 12:30  
Location / Room: University Booth, Booth 4, Exhibition Area

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More information ...
ISP RAS VERIFICATION TOOLS: INTEGRATED APPROACH TO HARDWARE VERIFICATION AT UNIT AND SYSTEM LEVELS BASED ON STATIC AND DYNAMIC METHODS

Presenter:
Andrei Tatarnikov, Institute for System Programming of the Russian Academy of Sciences (ISP RAS), RU

Abstract
Verification has long been recognized as an integral part of the hardware design process. As each hardware design is developed from unit- and core-level point of view, verification process should account this fact and provide means for dealing with both of them. Applied approaches include both static (formal methods, source code analysis) and dynamic (testing) methods. To facilitate verification, it is important to provide a uniform methodology that would allow integrating different approaches. In this work, we present a set of verification tools that takes advantage exactly of combining static and dynamic approaches. This allows knowledge sharing between tools, which helps to build more accurate models of hardware designs to be used in verification activities at different levels of abstraction. Brief descriptions of the tools are given below. MicroTESK is a reconfigurable (retargetable and extendable) model-based test program generator for microprocessors and other programmable devices. Lightweight formal specifications customize the generator for a particular architecture and provide knowledge about situations to be covered by tests. A convenient test template framework allows rapid development of complex verification scenarios. Being retargetable, MicroTESK is able to support various RISC and CISC architectures. C++TESK is an open-source C++ based toolkit intended for automated functional testing of software components (mostly in C/C++) and RTL (HDL) models of digital hardware (in Verilog and VHDL). The main part of the toolkit is a library of C++ classes and macros that define facilities for constructing formal specifications (reference models), adapters of components under test, test scenarios and test coverage metrics. Basing on C++ descriptions provided by a user, a test system is compiled. It allows automatically generating and applying sequences of stimuli to the component under test, checking correctness of its reactions and collecting statistics on test execution. Besides the basic library, the toolkit includes a report generator, means for parallelizing test execution on computer clusters, and Eclipse-based IDE. The toolkit is planned to be integrated into UVM methodology. Retrascope is an extendable toolkit for RTL (HDL) models transformation and functional verification at unit level. Analyzing source HDL-code, it extracts control and data flows, transforms them into Extended Finite State Machines (EFSM), and generates covering test sequences for them. The toolkit supports RTL modules written in VHDL and Verilog. It can be used both from command line and from Eclipse-based IDE.

More information ...

2.1 Executive Panel - New Opportunities in the Internet of Things

Date: Tuesday 10 March 2015
Time: 11:30 - 13:00
Location / Room: Salle Oisans

Organiser:
Yervant Zorian, Fellow & Chief Architect, Synopsys, US

Billions of devices connected to the internet is not too far from today's reality. Such an Internet of Things offers advanced connectivity between built-in sensors, field operation devices, and cloud systems, covering a variety of applications, including medical, home automation, energy, transportation, environmental monitoring, etc. This results in several new approaches and innovative methods that work together to enable the network of smart devices. Executives in this session will discuss the impact of IoT on the semiconductor industry and the new opportunities it may bring in designing today's Internet of Things.

Panelists:
- Mojir Chian, Silicon Cloud International, US
- Christoph Heer, Intel, DE
- Subramani Kengeri, GLOBALFOUNDRIES, US
- Philippe Magarshack, STMicroelectronics, FR
- Remy Potter, ARM, GB
- Yankin Tanurhan, Synopsys, US
2.2 Adaptability for Low Power Computing

**Date:** Tuesday 10 March 2015

**Location / Room:** Belle Etoile

**Chair:**
Patrick Knocke, OFFIS, DE

**Co-Chair:**
Ruzica Jevtic, Universidad Carlos III, ES

Run-time adaptability is increasingly exploited to improve efficiency of energy-scarce systems. This however inevitably brings serious increases in system complexity to optimally control the adaptability knobs and threatens system reliability. This session groups several approaches to achieve effective run-time reconfiguration at various levels of granularity. Adaptive strategies for multi-core task allocation, NV back-up storage, PV energy harvesting and multi-domain clock gating are presented.

### 2.2.1 CLOCK DOMAIN CROSSING AWARE SEQUENTIAL CLOCK GATING

**Speakers:**
Mohit Kumar¹, Jianfeng Liu², Mi-Suk Hong², Kyungtae Do², JungYun Choi², Jaehong Park², Abhishek Ranjan¹, Manish Kumar¹ and Nikhil Tripathi²

¹Calypso Design Systems, IN; ²SSI, Samsung Electronics Co. Ltd., KR

**Abstract**
Power has become the overriding concern for most modern electronic applications today. To reduce clock power, which is a significant portion of the dynamic power consumed by a design, sequential clock gating is increasingly getting used over and above combinational clock gating. With the shrinking device sizes and increasingly complex designs, data is frequently transferred from one clock domain to the other. The sequential clock gating optimizations can use signals from across sequential boundaries and thus, can introduce new clock domain crossing (CDC) violations which can cause catastrophic functional issues in the fabricated chip. Hence, it has become very important that sequential clock gating optimizations be CDC aware. In this paper, we present an algorithm to handle CDC violations as part of the objective function for sequential clock gating optimizations. With the proposed algorithm, we have obtained an average of 22% sequential power savings — this is within 3% of the power savings obtained by the CDC unaware sequential clock gating. In comparison, the state-of-the-art two-pass solution is leading to an almost complete loss of power savings.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 11:30 2.2.2 AN ENERGY EFFICIENT BACKUP SCHEME WITH LOW INRUSH CURRENT FOR NONVOLATILE SRAM IN ENERGY HARVESTING SENSOR NODES

**Speakers:**
Hehe Li¹, Yongpan Liu¹, Qinghang Zhao¹, Guangyu Sun¹, Chao Zhang¹, Yizi Gu¹, Rong Luo¹, Huazhong Yang¹, Meng-Fan Chang² and Xiao Sheng¹

¹Department of Electrical Engineering, National Tsing Hua University, TW; ²Center for Energy-Efficient Computing and Applications, EECS, Peking University, CN;

**Abstract**
In modern energy harvesting sensor nodes, nonvolatile SRAM (nvSRAM) has been widely investigated as a promising on-chip memory architecture because of its zero standby power, resilience to power failures, and fast read/write operations. However, conventional approaches transfer all data from SRAM into NVM during the backup process. Thus, large on-chip energy storage capacitors are normally required. In addition, high peak inrush current is generated instantaneously, which has a negative impact on energy efficiency and circuit reliability. To mitigate these problems, we propose a novel holistic backup flow, which consists of a partial backup process and a run-time pre-writeback scheme for nvSRAM based caches. A statistics based dead-block predictor is employed to achieve a fast and low power partial backup process. We also present an adaptive pre-writeback point allocation strategy to further reduce the backup load. Simulation results show that, with our proposed backup scheme, energy storage capacitance is reduced by 34% and inrush current is reduced by 54% on average compared to the conventional full backup scheme.

Download Paper (PDF; Only available from the DATE venue WiFi)
12:00 2.2.3 RACE TO IDLE OR NOT: BALANCING THE MEMORY SLEEP TIME WITH DVS FOR ENERGY MINIMIZATION

Speakers:
Chenchen Fu¹, Minming Li¹ and Jason Xue²

¹Department of Computer Science, City University of Hong Kong, HK; ²City University of Hong Kong, HK

Abstract
Reducing energy consumption is a critical problem in most of the computing systems today. In recent years, dynamic voltage scaling (DVS) has been often applied in the multi-core processor systems. The leakage power of the main memory shared by the multiple DVS cores is becoming a larger problem with technology scaling. This paper focuses on minimizing the system-wide energy consumption by applying DVS on each core and turning the memory to sleep when all the cores have common idle time. This work presents systematic analysis for the target problem based on different system models and task models. For tasks with common release time, optimal schemes are presented for the systems both with and without considering the static power of the cores. For the general task model, a heuristic online algorithm is proposed. Furthermore, the scheme is extended to handle the problem when the transition overhead between the active and sleep modes is not negligible. The experimental results show that the heuristic algorithm can reduce the energy consumption of the overall system by 8.73% in average (up to 28.44%) compared to a state-of-the-art multi-core DVS scheduling scheme.

Download Paper (PDF; Only available from the DATE venue WiFi)

12:45 2.2.4 EVENT-DRIVEN AND SENSORLESS PHOTOVOLTAIC SYSTEM RECONFIGURATION FOR ELECTRIC VEHICLES

Speakers:
Xue Lin¹, Yanzhi Wang², Massoud Pedram³, Jaemin Kim³ and Naehyuck Chang³

¹University of Southern California, US; ²Seoul National University, KR; ³Korea Advanced Institute of Science and Technology, KR

Abstract
This work investigates the problem of increasing the electrical energy generation efficiency of photovoltaic (PV) systems on electrical vehicles (EVs). Although PV power alone seems simply not sufficient to power an EV, the onboard PV system is still meaningful in mitigating the power demand of EV charging from the grid and reducing the environmental impact of EVs. The PV cell modules of an onboard PV system are mounted on the rooftop, hood, trunk, and door panels of an EV to fully make use of the vehicle surface areas. However, due to the non-uniform distribution and rapid change of solar irradiance, an onboard PV system suffers from significant efficiency degradation. To address this problem, this work borrows the dynamic PV array reconfiguration architecture in previous work with the accommodation of the rapidly changing solar irradiance in the onboard scenario. Most importantly, this work differs from previous work in that (i) we propose an event-driven PV array reconfiguration framework replacing the periodic reconfiguration framework in previous work to reduce the computation and energy overhead of the PV array reconfiguration; (ii) we provide a sensorless (and also event-driven) PV array reconfiguration framework, which further reduces the cost of a vehicular PV system, by proposing a solar irradiance estimation algorithm for obtaining the instantaneous solar irradiance level on each PV cell module.

Download Paper (PDF; Only available from the DATE venue WiFi)

13:00 IP1-1, 208 HIGH-RESOLUTION ONLINE POWER MONITORING FOR MODERN MICROPROCESSORS

Speakers:
Fabian Oboiri, Jos Ewert and Mehdi Tahoori, Karlsruhe Institute of Technology, DE

Abstract
The power consumption of computing systems is nowadays a major design constraint that affects performance and reliability. To co-optimize these aspects, fine-grained adaptation techniques at runtime are of growing importance. However, to use these tools efficiently, fine-grained information about the power consumption of various on-chip components at runtime is required. Therefore, here we propose a novel software-implemented high-resolution (spatial and temporal) power monitoring approach that relies on micro-models to estimate the power consumption of all microarchitectural components inside a processor core. Combined with a self-calibration technique that uses an available on-chip power sensor, our power estimation approach can achieve an accuracy of more than 99 % and provides deep insights about the power dissipation inside a processor core during workload execution.

Download Paper (PDF; Only available from the DATE venue WiFi)

13:01 IP1-2, 1013 REDUCING ENERGY CONSUMPTION IN MICROCONTROLLER-BASED PLATFORMS WITH LOW DESIGN MARGIN CO-PROCESSORS

Speakers:
Andres Gomez¹, Christian Pinto², Andrea Bartolini³, Davide Rossi³, Hamed Fatemi⁴, Jose Pineda de Gyvez⁴ and Luca Benini⁵

¹Swiss Federal Institute of Technology in Zurich (ETHZ), CH; ²Università di Bologna, IT; ³Università di Bologna / ETH Zurich, CH; ⁴XLP Semiconductors, NL; ⁵Università di Bologna / Swiss Federal Institute of Technology in Zurich (ETHZ), IT

Abstract
Advanced energy minimization techniques (i.e. DVFS, Thermal Management, etc) and their high-level HW/SW requirements are well established in high-throughput multi-core systems. These techniques would have an intolerable overhead in low-cost, performance-constrained microcontroller units (MCUs). These devices can further reduce power by operating at a lower voltage, at the cost of increased sensitivity to PVT variation and increased design margins. In this paper, we propose an runtime environment for next-generation dual-core MCU platforms. These platforms complement a single-core with a low area overhead, reduced design margin shadow-processor. The runtime decreases the overall energy consumption by exploiting design corner heterogeneity between the two cores, rather than increasing the throughput. This allows the platform's power envelope to be dynamically adjusted to application-specific requirements. Our simulations show that, depending on the ratio of core to platform energy, total energy savings can be up to 20%.

Download Paper (PDF; Only available from the DATE venue WiFi)
This session tackles complex system-level design problems in state-of-the-art FPGA-based designs and schedulability-critical systems. The first talk proposes a runtime system assigning multi-clock domains in FPGA-based designs for minimizing the makespan of multiple tasks. The second talk studies novel multi-cycling optimization in high-level synthesis which is driven by software profiling. The third talk presents useful schedulability analysis and formulation on execution time bound for integrated modular avionic systems. Finally two IP talks propose an automated design flow for asynchronous dataflow networks to achieve better performance and area as well as feature localization for synthesis.
2.4 Automotive Systems and Smart Energy Systems

**Date:** Tuesday 10 March 2015  
**Time:** 11:30 - 13:00  
**Location / Room:** Chartreuse  
**Chair:**  
Bart Vermeulen, NXP Semiconductors, NL  
**Co-Chair:**  
Geoff Merrett, University of Southampton, GB

This session covers energy optimisation for embedded systems and emerging automotive systems and networks, including Ethernet and IP. To create effective Ethernet-enabled automotive networks, topics including service discovery, bridging and traffic shaping are addressed.
A primary design optimization objective for multicore embedded systems is to minimize the energy consumption of applications while satisfying their performance requirement. A system-level approach to this problem is to scale the frequency of the processing cores based on the readings obtained from the hardware performance monitors. However, performance monitor readings contain uncertainty, which becomes prominent when applications are executed in a multicore environment. This uncertainty can be attributed to factors such as cache contention and DRAM access time, that are very difficult to predict dynamically. We demonstrate that such uncertainty can be controlled to make better decision on the processor frequency in order to minimize energy consumption. To achieve this, we propose a multinomial logistic regression model, which combines probabilistic interpretation with maximum likelihood (ML) estimation to classify an incoming workload, at run-time, into a finite set of classes. Every workload class corresponds to a frequency pre-determined using an appropriate training set and results in minimum energy consumption. The classifier incorporates (1) uncertainty with arbitrary probability distribution to estimate the actual frame workload; and (2) the frequency switching overhead, neither of which are considered in any of the existing approaches. The classified frequency is applied on the processing cores to execute the workload. The proposed approach is engineered into an embedded multicore system and is validated with a set of standard multimedia applications. Results demonstrate that the proposed approach minimizes energy consumption by an average 20% as compared to the existing techniques.
### 2.5 Power of Assertions

**Date:** Tuesday 10 March 2015  
**Time:** 11:30 - 13:00  
**Location / Room:** Meije

**Chair:**  
Franco Fummi, University of Verona, IT  
**Co-Chair:**  
Pablo Sanchez, University of Cantabria, ES

**Abstract**  
Assertions play a critical role in verification of hardware systems. This session is focusing on new applications of assertions in a wide variety of validation scenarios such as faster bug localization and post-silicon validation as well as reusing properties across abstraction levels.

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<th>Authors</th>
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| 13:00      | IPI-6 | LIGHTWEIGHT AUTHENTICATION FOR SECURE AUTOMOTIVE NETWORKS | Philipp Mundhenk¹, Sebastian Steinhorst¹, Martin Lukasiewycz¹, Suhaib A. Fahmy² and Samarjit Chakraborty³  
¹TUM CREATE, SG; ²School of Computer Engineering, Nanyang Technological University, SG; ³TU Munich, DE |

**Download Paper (PDF; Only available from the DATE venue WiFi)**

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**Tuesday, March 10, 2015**

- Coffee Break 10:30 - 11:30
- Lunch Break 13:00 - 14:30, Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
- Coffee Break 16:00 - 17:00

**Wednesday, March 11, 2015**

- Coffee Break 10:00 - 11:00
- Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)
- Coffee Break 16:00 - 17:00

**Thursday, March 12, 2015**

- Coffee Break 10:00 - 11:00
- Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
- Coffee Break 15:30 - 16:00

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### 2.5.1 Automatic Extraction of Assertions from Execution Traces of Behavioural Models

**Speakers:**  
Alessandro Danese, Tara Ghasempouri and Graziano Pravadelli, University of Verona, IT

**Abstract**  
Several approaches exist for specification mining of hardware designs. Most of them work at RTL and they extract assertions in the form of temporal relations between Boolean variables. Other approaches work at system level (e.g., TLM) to mine assertions that specify the behaviour of the communication protocol. However, these techniques do not generate assertions addressing the design functionality. Thus, there is a lack of studies related to the automatic mining of assertions for capturing the functionality of behavioural models, where logic expressions among more abstracted (e.g., numeric) variables than bits and bit vectors are necessary. This paper is intended to fill in the gap, by proposing a tool for automatic extraction of temporal assertions from execution traces of behavioural models by adopting a mix of static and dynamic techniques.

**Download Paper (PDF; Only available from the DATE venue WiFi)**

---

### 2.5.2 A Methodology for Automated Design of Embedded Bit-Flips Detectors in Post-Silicon Validation

**Speakers:**  
Pouya Taatizadeh and Nicola Nicolici, McMaster University, CA

**Abstract**  
Post-silicon validation is concerned with detecting design errors that escape to silicon prototypes and need to be fixed before committing to high-volume manufacturing. Electrical errors are particularly difficult to catch during the pre-silicon phase because of the insufficient accuracy of device models, which is often traded-off against simulation time. This challenge is further aggravated by the rising number of voltage domains, especially if subtle errors are excited in unique electrical states. Since these electrically-induced subtle errors most commonly manifest in the logic domain as bit-flips, to the best of our knowledge there are no systematic methods to design embedded hardware monitors for generic logic blocks that can detect bit-flips with low detection latency. Toward this goal, we propose a methodology that relies on design assertions that are ranked based on their potential to detect bit-flips and subsequently mapped into user-constrained embedded hardware monitors with the aim to increase bit-flip coverage estimate.

**Download Paper (PDF; Only available from the DATE venue WiFi)**
### DATA MINING DIAGNOSTICS AND BUG MRIS FOR HW BUG LOCALIZATION

**Speakers:**
Monica Farkash¹, Bryan Hickerson² and Balavinayagam Samynathan¹

¹University of Texas at Austin, US; ²IBM, US

**Abstract**
This paper addresses the challenge of minimizing the time and resources required to localize bugs in HW dynamic functional verification. Our diagnostics solution eliminates the need to back trace from point of failure to its origin, decreasing the overall debugging time. The proposed solution dynamically analyses data extracted from sets of passing and failing tests to identify behavior discrepancies, which it expresses as source code statements, coverage events and timing during simulation. It also provides a visual diagnostic support, an image of the behavior discrepancies in time which we call a Machine Reasoning Image (MRI). This paper describes in detail our data mining solution based on coverage data, HDL hierarchies and time analysis of coverage events. Our approach brings a data mining solution to the problem of HW bug localization. It defines new concepts, provides in-depth analysis, presents supporting algorithms, and shows actual results on archetypical problems from PowerPC core verification as an industrial application.

Download Paper (PDF; Only available from the DATE venue WiFi)

### RTL PROPERTY ABSTRACTION FOR TLM ASSERTION-BASED VERIFICATION

**Speakers:**
Nicola Bombieri¹, Riccardo Filippozzi¹, Graziano Pravadelli¹ and Francesco Stefanni²

¹University of Verona, IT; ²EDA Lab s.r.l., IT

**Abstract**
Different techniques and commercial tools are at the state of the art to reuse existing RTL IP models to generate more abstract (i.e., TLM) IP implementations for system-level design. In contrast, reusing, at TLM, an assertion-based verification (ABV) environment originally developed for an RTL IP is still an open problem. The lack of an effective and efficient solution forces verification engineers to shoulder a time consuming and error-prone manual re-definition, at TLM, of existing assertion libraries. This paper is intended to fill in the gap by presenting a technique to automatically abstract properties defined for RTL IPs and to create dynamic ABV environments for the corresponding TLM models.

Download Paper (PDF; Only available from the DATE venue WiFi)

### MINIMIZING THE NUMBER OF PROCESS CORNER SIMULATIONS DURING DESIGN VERIFICATION

**Speakers:**
Michael Shoniker, Bruce Cockburn, Jie Han and Witold Pedrycz, University of Alberta, CA

**Abstract**
Integrated circuit designs need to be verified in simulation over a large number of process corners that represent the expected range of transistor properties, supply voltages, and die temperatures. Each process corner can require substantial simulation time. Unfortunately, the required number of corners has been growing rapidly in the latest semiconductor technologies. We consider the problem of minimizing the required number of process corner simulations by iteratively learning a model of the output functions in order to confidently estimate key maximum and/or minimum properties of those functions. Depending on the output function, the required number of corner simulations can be reduced by factors of up to 95%.

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## 2.6 Design and Analysis of Dependable Systems

**Date:** Tuesday 10 March 2015  
**Location / Room:** Bayard

### Chair:
Arne Hamann, Robert Bosch GmbH, DE

### Co-Chair:
Viacheslav Izosimov, Semcon/KTH, SE

This section introduces new methods for uncertainty-aware reliability analysis and soft error vulnerability estimation as well as techniques for error recovery in safety-critical systems and security attacks through the JTAG port

**Time** | **Label** | **Presentation Title** | **Authors**
13:00 2.6.1 LOW-COST CHECKPOINTING IN AUTOMOTIVE SAFETY-RELEVANT SYSTEMS
Speakers:
Carles Hernandez and Jaume Abella, Barcelona Supercomputing Center (BSC-CNS), ES
Abstract
The use of checkpointing and roll-back recovery (CRR) schemes is common practice to increase the likelihood of a task completing with the correct result despite the presence of faults. However, the use of CRR mechanisms is challenging in the severely constrained design space of safety-relevant embedded systems, such as those controlling critical functions in the automotive domain. CRR schemes introduce non-negligible time and memory overheads that may jeopardise the feasibility of their implementation. In this paper we propose a low-cost checkpointing mechanism suitable for safety-relevant embedded systems deploying light-lockstep architectures. The proposed checkpointing mechanism increases the reliability of the system while keeping timing and memory overhead low enough.
Download Paper (PDF; Only available from the DATE venue WiFi)

12:00 2.6.2 UNCERTAINTY- AWARE RELIABILITY ANALYSIS AND OPTIMIZATION
Speakers:
Faramarz Khosravi, Malte Müller, Michael Gläß and Jürgen Teich, Friedrich-Alexander-Universität Erlangen-Nürnberg, DE
Abstract
Due to manufacturing tolerances and aging effects, future embedded systems have to cope with unreliable components. The intensity of such effects depends on uncertain aspects like environmental or usage conditions such that highly safety-critical systems are pessimistically designed for worst-case mission profiles. In this work, we propose to explicitly model the uncertain characteristics of system components, i.e. we model components using reliability functions with parameters distributed between a best and worst case. Since destructive effects like temperature may affect several components simultaneously (e.g. those in the same package), a correlation between uncertainties of components exists. The proposed uncertainty-aware method combines a formal analysis approach and a Monte Carlo simulation to consider uncertain characteristics and their different correlations. It delivers a holistic view on the system’s reliability with best/worst/average-case behavior but also insights on variance and quantities. However, existing optimization approaches typically assume design objectives to be single values or follow a predefined distribution known as noise. As a remedy, we propose a dominance criterion for meta-heuristic optimization approaches like evolutionary algorithms that enables the comparison of system implementations with arbitrarily distributed characteristics. Our presented experimental results show that (a) the proposed analysis comes at low overhead while capturing existing uncertainties with sufficient accuracy, and (b) the optimization process is significantly enhanced when guiding the search process by additional aspects like variance and the 95% quantile, delivering better system implementations as found by uncertainty-oblivious optimization approaches.
Download Paper (PDF; Only available from the DATE venue WiFi)

13:30 2.6.3 EFFICIENT SOFT ERROR VULNERABILITY ESTIMATION OF COMPLEX DESIGNS
Speakers:
Shahrzad Mirkhani1, Subhasish Mitra2, Chen-Yong Cher3 and Jacob Abraham4
1University of Texas at Austin, US; 2Stanford University, US; 3IBM Research, US; 4University of Texas, US
Abstract
Analyzing design vulnerability for soft errors has become a challenging process in large systems with a large number of memory elements. Error injection in a complex system with a sufficiently large sample of error candidates for reasonable accuracy takes a large amount of time. In this paper we describe RAVEN, a statistical method to estimate the outcomes of a system in the presence of soft errors injected into flip-flops, as well as the vulnerability for each memory element. This method takes advantage of fast local simulations for each error injection, and calculates the probabilities for the system outcomes for every possible soft error in a period of time. Experimental results, on an out-of-order processor with SPECINT2000 workloads, show that RAVEN is an order of magnitude faster compared with traditional error injection while maintaining accuracy.
Download Paper (PDF; Only available from the DATE venue WiFi)

12:45 2.6.4 DETECTION OF ILLEGITIMATE ACCESS TO JTAG VIA STATISTICAL LEARNING IN CHIP
Speakers:
Xuanle Ren1, Vitor Grade Tavares2 and Shawn Blanton1
1Carnegie Mellon University, US; 2Faculdade de Engenharia da Universidade do Porto, PT
Abstract
IEEE 1149.1, commonly known as the joint test action group (JTAG), is the standard for the test access port and the boundary-scan architecture. The JTAG is primarily utilized at the time of the integrated circuit (IC) manufacture but also in the field, giving access to internal sub-systems of the IC, or for failure analysis and debugging. Because the JTAG needs to be left intact and operational for use, it inevitably provides a “backdoor” that can be exploited to undermine the security of the chip. Potential attackers can then use the JTAG to dump critical data or reverse engineer IP cores, for example. Since an attacker will use the JTAG differently from a legitimate user, it is possible to detect the difference using machine-learning algorithms. A JTAG protection scheme, SLIC-I, is proposed to monitor user behavior and detect illegitimate accesses to the JTAG. Specifically, JTAG access is characterized using a set of specifically-defined features, and then an on-chip classifier is used to predict whether the user is legitimate or not. To validate the effectiveness of the approach, both legitimate and illegitimate JTAG accesses are simulated using the OpenSPARC T2 benchmark. The results show that the detection accuracy is 99.2%, and the escape rate is 0.8%.
Download Paper (PDF; Only available from the DATE venue WiFi)

13:00 2.6.5 AN APPROXIMATE VOTING SCHEME FOR RELIABLE COMPUTING
Speakers:
Ke Chen1, Jie Han2 and Fabrizio Lombardi1
1Northeastern University, US; 2University of Alberta, CA
Abstract
This paper relies on the principles of inexact computing to alleviate the issues arising in static masking by voting for reliable computing. A scheme that utilizes approximate voting is proposed; it is referred as inexact double modular redundancy (IDMR). IDMR does not resort to triplication, thus saving overhead due to modular replication; moreover, this scheme is adaptive in its operation, i.e., it allows a threshold to determine the validity of the module outputs. IDMR operates by initially establishing the difference between the values of the outputs of the two modules; only if the difference is below a preset threshold, then the voter calculates the average value of the two module outputs. An extensive analysis of the voting circuits and an application to image processing are presented.
Download Paper (PDF; Only available from the DATE venue WiFi)

13:01 2.6.6 FLINT: LAYOUT-ORIENTED FPGA-BASED METHODOLOGY FOR FAULT TOLERANT ASIC DESIGN
Speakers:
Rochus Nowosielski, Lukas Gerlach, Stephan Bieband, Guillermo Paya-Vaya and Holger Blume, Leibniz Universität Hannover, Institute of Microelectronic Systems, DE
Abstract
Research of efficient fault tolerance techniques for digital systems requires insight into the fault propagation mechanism inside the ASIC design. Radiation, high temperature, or charge sharing effects in ultra-deep submicron technologies influence fault generation and propagation dependent on die location. The proposed methodology links efficient fault injection to fault propagation in the floorplan view of a standard cell ASIC. This is achieved by instrumentation of the gate netlist after place&route, emulation in an FPGA system and experiment control via interactive user interface. Further, automated fault injection campaigns allow exhaustive fault tolerance evaluations taking single faults as well as adjacent cell faults into account. The proposed methodology can be used to identify vulnerable cell nodes in the design and allow the optimization of placement strategies of fault tolerant ASIC designs.
Download Paper (PDF; Only available from the DATE venue WiFi)
13:00 End of session

Lunch Break, Keynote session from 1320 - 1420 (Room Oisans) sponsored by Mentor Graphics in front of the session room Salle Oisans and in the Exhibition area

Coffee Break in Exhibition Area

On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area.

Lunch Break

On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Ecrins (for fully registered conference delegates only).

Tuesday, March 10, 2015

Coffee Break 10:30 - 11:30

Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics

Coffee Break 16:00 - 17:00

Wednesday, March 11, 2015

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)

Coffee Break 16:00 - 17:00

Thursday, March 12, 2015

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00

2.7 Compilation and Code Transformations for Reconfigurable Computing

Date: Tuesday 10 March 2015
Time: 11:30 - 13:00
Location / Room: Les Bans

Chair: Dirk Stroobandt, Ghent University, BE
Co-Chair: Marco Platzner, University of Paderborn, DE

This session presents techniques for efficient compilation to CGRAs and a code transformation approach to enhance embedded system security.

<table>
<thead>
<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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<tbody>
<tr>
<td>11:30</td>
<td>2.7.1</td>
<td>JOINT AFFINE TRANSFORMATION AND LOOP PIPELINING FOR MAPPING NESTED LOOP ON CGRA</td>
<td>Shouyi YIN¹, Dajiang Liu¹, Leibo Liu², Shaojun Wei¹ and Yike Guo³</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>¹Tsinghua University, CN; ²Institute of Microelectronics and The National Lab for Information Science and Technology, Tsinghua University, CN; ³Imperial College, London, UK, GB</td>
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<tr>
<td></td>
<td></td>
<td>Abstract</td>
<td>Coarse-Grained Reconfigurable Architectures (CGRAs) are the promising architectures with high performance, high power-efficiency and attractive flexibility. The computation-intensive portions of application, i.e. loops, are often implemented on CGRAs for acceleration. The loop pipelining techniques are usually used to exploit the parallelism of loops. However, for nested loops, the existing loop pipelining methods often result in poor hardware utilization and low execution performance. To tackle this problem, this paper makes two contributions: 1) a pipelining-beneficial affine transformation method which can optimize the initiation interval (II) of nested loop and enable multiple loop pipelines merging; 2) a multi-pipeline merging method which can improve hardware utilization further. The experimental results show that our approach can improve the performance of nested loop by up to 56% on average, as compared to the state-of-the-art techniques.</td>
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<tr>
<td>12:00</td>
<td>2.7.2</td>
<td>PATH SELECTION BASED ACCELERATION OF CONDITIONALS IN CGRAS</td>
<td>Shri Hari Rajendran Radhika, Aviral Shrivastava and Mahdi Hamzeh, Arizona State University, US</td>
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<tr>
<td></td>
<td></td>
<td>Abstract</td>
<td>Coarse Grain Reconfigurable Arrays (CGRAs) are promising accelerators capable of achieving high performance at low power consumption. While CGRAs can efficiently accelerate loop kernels, accelerating loops with control flow (loops with if-then-else structures) is quite challenging. Existing techniques use predication to control flow execution - in which they execute operations from both the paths, but commit only the ones from the correct path but this scheme has an overhead in instruction fetch bandwidth. In this paper, we propose a solution in which after resolving the branching condition, we fetch and execute instructions only from the path taken by branch. Experimental results show that our solution achieves 34.6% better performance and 52.1% lower energy consumption on an average compared to state of the art dual issue scheme without imposing any overhead in instruction fetch bandwidth.</td>
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Abstract

Domain-Specific Languages (DSLs) are increasingly used in industrial processes to separate and abstract the various concerns of complex systems. Concurrency is of primary interest in the development of complex software-intensive systems, as well as the deployment on modern platforms. However, reifying the definition of the DSL concurrency remains a challenge. This not only prevents leveraging the concurrency concern of a particular domain or platform, but it also hinders: (1) the development of a complete understanding of the DSL semantics; (2) the effectiveness of concurrency-aware analysis techniques; (3) the analysis of the deployment on parallel architectures. In this paper, we introduce the key ideas leading toward MoCCML, a dedicated meta-language for formally specifying the concurrency concern within the definition of a DSL. The concurrency constraints can reflect the knowledge in a particular domain, but also the constraints of a particular platform. MoCCML comes with a complete language workbench to help a DSL designer in the definition of the concurrency directly within the concepts of the DSL itself, and a generic workbench to simulate and analyze any model conforming to this DSL. MoCCML is illustrated on the definition of an lightweight extension of SDF (Synchronous Data Flow).

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End of session

Lunch Break, Keynote session from 1320 - 1420 (Room Oisans) sponsored by Mentor Graphics in front of the session room Salle Oisans and in the Exhibition area

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Tuesday, March 10, 2015

Coffee Break 10:30 - 11:30

Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics

Coffee Break 16:00 - 17:00

Wednesday, March 11, 2015

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)

Coffee Break 16:00 - 17:00

Thursday, March 12, 2015

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00

2.8 Facilities for Design and Fabrication for FD-SOI IC

Date: Tuesday 10 March 2015
Time: 11:30 - 13:00
Location / Room: Salle Lesdiguières

Organiser:
Ahmed Jerraya, CEA-Leti, FR

Moderator:
Carlo Reita, CEA-Leti, FR

Panelists:
Gerd Teepe, GLOBALFOUNDRIES, DE
Patrick Blouet, STMicroelectronics, FR
Olivier Thomas, CEA-Leti, FR

FD-SOI technology enables low cost and energy efficient designs best suited for today consumer, IoT and automotive applications, in continuity with traditional planar technologies simpler to design and manufacture with. The talks will illustrate the availability of a full FD-SOI technology ecosystem, encompassing IC fabrication, IP availability and design experiences.

Time | Label | Presentation Title | Authors
--- | --- | --- | ---
11:30 | 2.8.1 | FD-SOI TECHNOLOGY ROADMAP | Carlo Reita, CEA-Leti, FR
11:45 | 2.8.2 | FOUNDRY SERVICES FOR FD-SOI | Gerd Teepe, GLOBALFOUNDRIES, DE
12:00 | 2.8.3 | FD-SOI DESIGN AND IP ECOSYSTEM | Patrick Blouet, STMicroelectronics, FR
12:15 | 2.8.4 | INDUSTRIAL FD-SOI MPW AND GRENOBLE IC DESIGN CENTER | Olivier Thomas, CEA-Leti, FR
12:30 | 2.8.5 | DISCUSSION |
13:00
End of session

Lunch Break, Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics in front of the session room Salle Oisans and in the Exhibition area

Coffee Break in Exhibition Area

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Tuesday, March 10, 2015
Coffee Break 10:30 - 11:30
Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
Coffee Break 16:00 - 17:00

Wednesday, March 11, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)
Coffee Break 16:00 - 17:00

Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

UB02 Session 2

Date: Tuesday 10 March 2015
Time: 12:30 - 15:00
Location / Room: University Booth, Booth 4, Exhibition Area

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<tr>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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<tbody>
<tr>
<td>UB02.1</td>
<td>STRNG: A SELF-TIMED RING BASED TRUE RANDOM NUMBER GENERATOR WITH MONITORING AND ENTROPY ASSESSMENT</td>
<td>Abdelkarim Chérkaoui, TIMA, FR</td>
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<td>Presenters: Laurent Fesquet, Viktor Fischer and Alain Aubert</td>
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<td>Authors: Laurent Fesquet, Viktor Fischer and Alain Aubert</td>
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<td>ITIMA, FR; LaHC, FR</td>
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<td>Abstract: The Self-timed ring based True Random Number Generator (STRING) leverages the jitter of events propagating in a self-timed ring to generate provably random binary sequences. Several implementations in FPGAs and in CMOS design flows have shown the feasibility of this generator in digital technologies, and also confirmed that it can provide high quality random bit sequences that pass the standard statistical test batteries at rates as high as 200 Mbit/s. Following AIS31 recommendations for the design and evaluation of TRNGs, the security of this generator is based primarily on an entropy assessment obtained by modeling the entropy extraction and measuring the entropy source. Secondly, the generator is protected against active attacks by monitoring its behavior in real-time or on demand. In this demonstration, we illustrate this approach in an Altera Cyclone III implementation of the STRING. We show how the design is configured depending on the measurement of the entropy source (the jitter magnitude) in order to guarantee a given minimum entropy rate per output bit. Then, we emulate physical attacks on the generator by willingly manipulating its internal structure in order to demonstrate how the entropy monitoring can detect abnormal behaviors and send the appropriate alarms.</td>
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<tr>
<td>UB02.2</td>
<td>PARLOMA: A REMOTE COMMUNICATION SYSTEM FOR DEAFBLIND PEOPLE</td>
<td>Ludovico Orlando Russo, Politecnico di Torino, IT</td>
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<td>Presenters: Giuseppe Airò Farulla, Marco Indaco, Calogero Maria Oddo, Daniele Pianu, Paolo Prinetto, Stefano Rosa and Ludovico Orlando Russo</td>
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<tr>
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<td>Authors: Giuseppe Airò Farulla, Marco Indaco, Calogero Maria Oddo, Daniele Pianu, Paolo Prinetto, Stefano Rosa and Ludovico Orlando Russo</td>
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<tr>
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<td>Politecnico di Torino, IT; Scuola Superiore Sant’Anna, The Biorobotics Institute, IT; CNR, IEIIT, IT</td>
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<td>Abstract: This work aims at designing a low-cost communication system to allow remote communication among deafblind people, up to now impossible. Due to their lacking of both the auditory and the visive channel, deafblind people can receive feedbacks and mes-sages only resorting on hand-in-hand communication and only from speakers physically located near them. Such limitation ag-gravates their situation and cause deafblind people to live behind a wall of isolation from active society. PARLOMA aims at breaking this wall, developing a tool that can be used by deafblind people to communicate whenever they want and wherever they are.</td>
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<td>UB02.3</td>
<td>BONDCALC: THE BOND CALCULATOR</td>
<td>Carl Christoph Jung, Reutlingen University, DE</td>
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<td>Presenters: Carl Christoph Jung, Reutlingen University, DE</td>
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<td>Authors: Christian Silber, Juergen Scheible</td>
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<td>Robert Bosch GmbH, DE; Reutlingen University, DE</td>
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<td>Abstract: The Bond Calculator is a fast and exact tool to help designers to choose a bond wire, which does not fuse. The Bond Calculator is orders of magnitude faster than FEM and easy-to-use. The Bond Calculator helps designers to estimate the temperature at the bond connection itself, by calculating the time and space dependence of the power delivered from the bond wire to the chip. These temperature changes can affect the durability of the bond connection. The Bond Calculator uses a simplified simulation model to calculate the temperature profile in a bond wire from the induced current profile. This software tool has been validated by FEM and measurement.</td>
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HIPER-NIRGAM: A TOOL CHAIN BASED FRAMEWORK FOR MODELLING THERMAL - AWARE RELIABILITY ESTIMATION IN 2D MESH NOCS

Presenter:
Ashish Sharma, Malaviya National Institute of Technology, Jaipur, IN
Authors:
Manoj Singh Gaur1, Lava Bhargava1, Vijay Laxmi1 and Mark Zwolinski2
1Malaviya National Institute of Technology, Jaipur, IN; 2University of Southampton, GB

Abstract
Every three years, power density in system-on-chip (SoCs) gets doubled. As the semiconductor technology is scaling, the number of cores and interconnect network connections are increasing. To improve system performance while meeting permissible power limits, Chip-Multi Processors (CMPs) and many-core processors have emerged as an appealing solution. One of the significant aspects of many-core design is an on chip interconnect network that can effectively support intra-core and inter-core communications. This interconnect should be scalable, support high communication bandwidth and multiple concurrent connections among cores. Network-on-chip (NoC) replaces the traditional bus-based interconnect architecture as former is scalable, has higher bandwidth, fault tolerance and offers parallelism. Regular NoC topologies improve scalability too. Adaptive NoC routing solutions distribute power densities and delay onset of hotspot creation. With ever-growing demand of computation and communication bandwidth by applications, the design engineer need to consider and address resultant power and thermal issues in SoC as well as NoC design. Design tools need to incorporate thermal effects in design and evaluation of prototypes. Abstract—Regional temperature differential and hotspots are two thermal problems in network-on-chip. On-chip thermal problems have an adverse impact on system performance and reliability. We propose creation of a toolchain based framework for incorporating thermal evaluation of NoC through existing simulation tools. Our proposed framework provides an integration of NoC simulator with power and thermal simulation models for analyzing the thermal hotspots and can be used for thermal-aware reliability estimation. In our framework, reliability estimation is based on life time failure models such as TDDB (Time dependent dielectric breakdown), NBTI (Negative bias temperature instability) and SM (Stress Migration). In our proposed reliability measurement is based on MTTF (Mean time to failure) comparative value. Our tool chain consists NIRGAM as a NoC simulator, NoC configuration parameters such as number of virtual channel, buffer size, routing logic, simulation cycles and application traffic are passed to power models (Orion 2.0 and McPAT). Power models provide the power trace and area of given NoC configuration. The power model results are further used in HotSpot 5.02 (HOTSPOt) thermal simulation model for generating floorplan and temperature trace (steady temperature file). The steady temperature trace used in reliability estimation tool REST (REST_tool) to estimating MTTF values.

More information ...

REAL-TIME MULTIPROCESSOR COMPILER DEMO: COMPILER FOR REAL-TIME MULTIPROCESSOR SYSTEMS WITH SHARED ACCELERATORS

Presenter:
Marco Bekooij, University of Twente, NL
Authors:
Guus Kuiper, Stefan Geurs, Philip Wilmanns, Joost Haasnoot and Marco Bekooij, University of Twente, NL

Abstract
Accelerators are added in real-time multiprocessor systems for power-efficiency improvement and cost reduction. Sharing of these accelerators improves their utilization but without tool support it also complicates programming. This demonstration shows a multiprocessor compiler for a real-time multiprocessor system that contains support for the sharing of hardware accelerators. The capabilities of this compiler are demonstrated by mapping a packet based GMSK receiver application onto this multiprocessor system. The multiprocessor system is implemented on a Xilinx Virtex-6 FPGA to which an RF front-end is connected. This multiprocessor system contains 16 Microblaze processors and 5 accelerators. With this system a real-time digital audio stream is received and demodulated.

More information ...

ISIS: CUSTOMIZABLE RUNTIME VERIFICATION OF HARDWARE/SOFTWARE VIRTUAL PLATFORMS

Presenter:
Laurence Pierre, TIMA, FR
Author:
Martial Chabot, TIMA, FR

Abstract
Debugging today’s hardware/software embedded systems is a complex process. We have previously described our tool, ISIS, that enables the runtime Assertion-Based Verification (ABV) of temporal requirements for high-level (SystemC TLM) models of such systems. We present here an extended version of the tool, that gives the user the possibility to customize and to optimize the verification process.

More information ...

VHDL TO SYSTEMC TRANSLATION AND ABSTRACTION: SYSTEMC MANIPULATION FRAMEWORK: FROM RTL VHDL TO OPTIMIZED TLM SYSTEMC

Presenter:
Syed Saif Abrar, Tallinn University of Technology, EE
Authors:
Syed Saif Abrar, Valentin Tihomirov, Maxim Jenihiin and Jaan Raik, Tallinn University of Technology, EE

Abstract
We propose a novel framework for SystemC manipulation based on the open-source hardware design and analysis environment zamiaCAD. The framework provides for optimized VHDL-to-SystemC Translation and subsequent abstraction to higher-levels. It includes an Eclipse-based front-end and is integrated to a comprehensive environment for RTL VHDL analysis, simulation and debug.

More information ...

ID.FIX: AN EDA TOOL FOR FIXED-POINT REFINEMENT OF EMBEDDED SYSTEMS

Presenter:
Olivier Senteys, INRIA, FR
Authors:
Daniel Menardi1 and Nicolas Simon2
1INSA Rennes, FR; 2INRIA, FR

Abstract
Most of digital image and signal processing algorithms are implemented into architectures based on fixed-point arithmetic to satisfy cost and power consumption constraints associated with most of embedded and cyber-physical systems. The fixed-point conversion process (or refinement) is crucial for reducing the time-to-market and design tools to automate this phase and to explore the design space are still lacking. The ID.Fix EDA tool, based on the compiler infrastructure GECOS, allows for the conversion of a floating-point C source code into a C code using fixed-point data types. The data word-lengths are optimized by minimizing the implementation cost under accuracy constraint. To achieve low optimization time, an analytical approach is used to evaluate the fixed-point computation accuracy. This approach is valid for systems made-up of any smooth arithmetic operations. Commercial tools can then be used to synthesize the architecture or to perform software compilation from the output fixed-point description of the application. Thus, the goal is to bridge the gap between the floating-point description developed by algorithm designer and the fixed-point description use as input for high-level synthesis or compilation tools.

More information ...

15:00 End of session
On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area.

**Lunch Break**

On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Ecrins (for fully registered conference delegates only).

**Tuesday, March 10, 2015**

Coffee Break 10:30 - 11:30

Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics

Coffee Break 16:00 - 17:00

**Wednesday, March 11, 2015**

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)

Coffee Break 16:00 - 17:00

**Thursday, March 12, 2015**

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00

### 3.0 LUNCH TIME KEYNOTE SESSION: “How micro-electronic will change your life style” sponsored by Mentor Graphics

**Date:** Tuesday 10 March 2015  
**Time:** 13:20 - 14:20  
**Location / Room:** Salle Oisans

**Chair:**  
Jean-Marie Saint-Paul, Mentor, FR

Microelectronics is opening new vistas in our lives by changing the way we interact with our environment. Speech recognition, Drones and Robots are not only advanced research topics, these are surrounding our daily activities, sharing our lives and may induce a much larger transformation of our life style than we could have imagined 10 years ago. This session will bring together high profile products and vision to show the ongoing transformation.

<table>
<thead>
<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>13:20</td>
<td>3.0.1</td>
<td>NEW LIFE STYLES BEYOND YOUR DREAMS</td>
<td>Thierry Collette, CEA-Leti, FR</td>
</tr>
<tr>
<td>13:30</td>
<td>3.0.2</td>
<td>DRONES THAT FLY FOR YOU</td>
<td>Nicolas Besnard, Parrot, FR</td>
</tr>
<tr>
<td>13:50</td>
<td>3.0.3</td>
<td>ROBOTS THAT LIVE WITH YOU</td>
<td>Rodolphe Gelin, Aldebaran, FR</td>
</tr>
<tr>
<td>14:20</td>
<td></td>
<td>End of session</td>
<td></td>
</tr>
<tr>
<td>16:00</td>
<td></td>
<td>Coffee Break in Exhibition Area</td>
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</tbody>
</table>

**16:00 Coffee Break in Exhibition Area**

Coffee Break in Exhibition Area

On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area.

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**Thursday, March 12, 2015**

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00

### 3.1 Executive Panel - Extending Moore’s Law & Heterogeneous Integration
Systemic scaling in today’s new applications is dramatically impacting the semiconductor industry. As a result, certain applications are moving to new advanced semiconductor nodes and others are adopting heterogeneous integration using multi-die modules. In addition to the technical challenges in each case, these solutions significantly affect the dependency between eco-system players necessitating smooth interdependency between them. The executives in this session will discuss the solutions in the semiconductor industry and their impact on the eco system players.

Panelists:
- Antun Domic, Synopsys, US
- Rudy Lauwereins, IMEC, BE
- Didier Tettart, TSMC Europe, NL

16:00 End of session
Coffee Break in Exhibition Area

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Lunch Break
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Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

3.2 Passive Implementation Attacks and Countermeasures

Passive implementation attacks are a major security threat for embedded systems. This session focuses on improving side-channel analysis considering reliable key extraction, information leakage of static power consumption, and processor instructions. It also presents a monitor to defeat write-back attacks on caches.

<table>
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<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:30</td>
<td>3.2.1</td>
<td>RELIABLE INFORMATION EXTRACTION FOR SINGLE TRACE ATTACKS</td>
<td>Valentina Banciu, Elisabeth Oswald and Carolyn Whitnall, University of Bristol, GB</td>
</tr>
</tbody>
</table>

Abstract
Side-channel attacks using only a single trace crucially rely on the capability of reliably extracting side-channel information (e.g. Hamming weights of intermediate target values) from traces. In particular, in original versions of simple power analysis (SPA) or algebraic side channel attacks (ASCA) it was assumed that an adversary can correctly extract the Hamming weight values for all the intermediates used in an attack. Recent developments in error tolerant SPA style attacks relax this unrealistic requirement on the information extraction and bring renewed interest to the topic of template building or training suitable machine learning classifiers. In this work we ask which classifiers or methods, if any, are most likely to return the true Hamming weight among their first (say s) ranked outputs. We experiment on two data sets with different leakage characteristics. Our experiments show that the most suitable classifiers to reach the required performance for pragmatic SPA attacks are Gaussian templates, Support Vector Machines and Random Forests, across the two data sets that we considered. We found no configuration that was able to satisfy the requirements of an error tolerant ASCA in case of complex leakage.

Download Paper (PDF; Only available from the DATE venue WiFi)
3.2 Loop Acceleration

16:00 3.2.2 SCANDALEE: A SIDE-CHANNEL-BASED DISASSEMBLER USING LOCAL ELECTROMAGNETIC EMANATIONS

Speakers:
Daehyun Strobel, Florian Bache, David Oswald, Falk Schellenberg and Christof Paar, Horst Görtz Institute for IT-Security, Ruhr-University Bochum, DE

Abstract
Side-channel analysis has become a well-established topic in the scientific community and industry over the last one and a half decade. Somewhat surprisingly, the vast majority of work on side-channel analysis has been restricted to the "use case" of attacking cryptographic implementations through the recovery of keys. In this contribution, we show how side-channel analysis can be used for extracting code from embedded systems based on a CPU's electromagnetic emanation. There are many applications within and outside the security community where this is desirable. In cryptography, it can, e.g., be used for recovering proprietary ciphers and security protocols. Another broad application field is general security and reverse engineering, e.g., for detecting IP violations of firmware or for debugging embedded systems when there is no debug interface or it is proprietary. A core feature of our approach is that we take localized electromagnetic measurements that are spatially distributed over the IC being analyzed. Given these multiple inputs, we model code extraction as a classification problem that we solve with supervised learning algorithms. We apply a variant of linear discriminant analysis to distinguish between the multiple classes. In contrast to previous approaches, which reported instruction recognition rates between 40-70%, our approach detects more than 95% of all instructions for test code, and close to 90% for real-world code. The methods are thus very relevant for use in practice. Our method performs dynamic code recognition, which has both advantages (only the program parts that are actually executed are observed) but also limitations (rare code executions are difficult to observe).

Download Paper (PDF; Only available from the DATE venue WiFi)

15:30 3.2.3 SIDE-CHANNEL ATTACKS FROM STATIC POWER: WHEN SHOULD WE CARE?

Speakers:
Santos Merino del Pozo1, Francois-Xavier Standaert1, Dina Kamel1 and Amir Moradi2
1UCL Crypto Group, BE; 2Ruhr University Bochum, DE

Abstract
Static power consumption is an increasingly important concern when designing circuits in deep submicron technologies. Besides its impact for low-power implementations, recent research has investigated whether it could lead to exploitable side-channel leakages. Both simulated analyses and measurements from FPGA devices have confirmed that such a static signal can indeed lead to successful key recoveries. In this respect, the main remaining question is whether it can become the target of choice for actual adversaries, especially since it has smaller amplitude than its dynamic counterpart. In this paper, we answer this question based on actual measurements taken from an AES S-box prototype chip implemented in a 65-nanometer CMOS technology. For this purpose, we first provide a fair comparison of the static and dynamic leakages in a univariate setting, based on worst-case information theoretic analysis. This comparison confirms that the static signal is significantly less informative than the dynamic one. Next, we extend our evaluations to a multivariate setting. In this case, we observe that simple averaging strategies can be used to reduce the noise in static leakage traces. As a result, we mainly conclude that (a) if the target chip is working at maximum clock frequency (which prevents the previously mentioned averaging), the static leakage signal remains substantially smaller than the dynamic one, so has limited impact, and (b) if the adversary can reduce the clock frequency, the noise of the static leakage traces can be reduced arbitrarily. Whether the static signal leads to more informative leakages than the dynamic one then depends on the quality of the measurements (as the former one has very small amplitude). But it anyway raises a warning flag for the implementation of algorithmic countermeasures such as masking, that require high noise levels.

Download Paper (PDF; Only available from the DATE venue WiFi)

15:45 3.2.4 EXTRAX: SECURITY EXTENSION TO EXTRACT CACHE RESIDENT INFORMATION FOR SNOOP-BASED EXTERNAL MONITORS

Speakers:
Jinyong Lee1, Yongje Lee1, Hyungon Moon1, Ingoo Heo1 and Yunheung Paek1
1Seoul National University, KR; 2Seoul National University, Samsung Electronics Co., Ltd., KR

Abstract
Advent of rootkits has urged researchers to conduct much research on defending the integrity of OS kernels. Even though recently proposed snoop-based monitors have shown to provide higher performance and security level compared to conventional hypervisor-based monitors, we discovered that the use of write-back caches in a system would seriously undermine the effectiveness of snoop-based monitors. To address the problem, we propose a special hardware unit called Extrax which makes use of existing hardware logic, core debugging interface, to extract necessary information for security monitoring. Being implemented to refine the debug information for security purposes, Extrax assists snoop-based monitors to detect attacks that exploit write-back caches. Experimental results show that our system can detect more advanced attacks, which the state-of-the-art snoop-based hardware monitors cannot capture, with moderate area overhead and power consumption.

Download Paper (PDF; Only available from the DATE venue WiFi)

16:00

End of session

Coffee Break in Exhibition Area

Coffee Break in Exhibition Area

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Lunch Break

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Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00
This session reveals novel loop optimization techniques in high-level synthesis for resolving area overhead and communication bottlenecks in nested loops and/or multidimensional arrays. The first talk leverages loop-array dependencies for loop partitioning to reduce the dimension of the design space in order to ease the design complexity. The second talk quantifies a relationship between loop unrolling and partitioning, based on which area reduction methods are proposed by controlling the degree of loop unrolling. The third talk then resolves communication bottlenecks in embedded accelerators through inter-tile data reuse on loop optimizations.

**Time** | **Label** | **Presentation Title** | **Authors**
---|---|---|---
14:30 | 3.3.1 | EXPLOITING LOOP-ARRAY DEPENDENCIES TO ACCELERATE THE DESIGN SPACE EXPLORATION WITH HIGH LEVEL SYNTHESIS | Nam Khanh Pham1, Amit Kumar Singh2, Akash Kumar3 and Mi Mi Aung Khin4

1ECE Department, National University of Singapore, SG; 2University of York, GB; 3National University of Singapore, SG; 4Data Storage Institute (DSI), A*STAR, Singapore., SG

Abstract

Recently, the requirement of shortened design cycles has led to rapid development of High Level Synthesis (HLS) tools that convert system level descriptions in a high level language into efficient hardware designs. Due to the high level of abstraction, HLS tools can easily provide multiple hardware designs from the same behavioral description. Therefore, they allow designers to explore various architectural options for different design objectives. However, such exploration has exponential complexity, making it practically impossible to explore the entire design space. The conventional approaches to reduce the design space exploration (DSE) complexity do not analyze the structure of the design space to limit the number of design points. To fill such a gap, we explore the structure of the design space by analyzing the dependencies between loops and arrays. We represent these dependencies as a graph that is used to reduce the dimensions of the design space. Moreover, we also examine the access pattern of the array and utilize it to find the efficient partition of arrays for each loop optimization parameter set. The experimental results show that our approach provides almost the same quality of result as the exhaustive DSE approach while significantly reducing the exploration time with an average of speed-up of 14x.

Download Paper (PDF; Only available from the DATE venue WiFi)

15:00 | 3.3.2 | INTERPLAY OF LOOP UNROLLING AND MULTIDIMENSIONAL MEMORY PARTITIONING IN HLS | Alessandro Cilardo and Luca Gallo, University of Naples Federico II, IT

Abstract

This paper deals with memory partitioning in the context of high-level synthesis for FPGA technologies. In particular, the work focuses on the area overhead caused by partitioning and sheds light on the interplay with a technique commonly used in HLS, i.e., loop unrolling. As a practical outcome, the study proposes a solution to reduce the area overhead by appropriately controlling the degree of loop unrolling. The experimental results confirm the significance of the analysis as well as the effectiveness of the proposed optimization technique.

Download Paper (PDF; Only available from the DATE venue WiFi)

15:30 | 3.3.3 | INTER-TILE REUSE OPTIMIZATION APPLIED TO BANDWIDTH CONSTRAINED EMBEDDED ACCELERATORS | Maurice Peemen, Bart Mesman and Henk Corporaal, Eindhoven University of Technology, NL

Abstract

The adoption of High-Level Synthesis (HLS) tools has significantly reduced accelerator design time. A complex scaling problem that remains is the data transfer bottleneck. To scale-up performance accelerators require huge amounts of data, and are often limited by interconnect resources. In the energy spent by the accelerator is dominated by the transfer of data, either in the form of memory references or data movement on interconnect. In this paper we drastically reduce accelerator communication by exploration of computation reordering and local buffer usage. Consequently, we present a new analytical methodology to optimize nested loops for inter-tile data reuse with loop transformations like interchange and tiling. We focus on embedded accelerators that can be used in a multi-accelerator System on Chip (SoC), so performance, area, and energy are key in this exploration. 1) On three common embedded applications in the image/video processing domain (demosaicing, block matching, object detection), we show that our methodology reduces data movement up to 2.1x compared to the best case of intra-tile optimization. 2) We demonstrate that our small accelerators (1-3% FPGA resources) can boost a simple MicroBlaze soft-core to the performance level of a high-end Intel-i7 processor.

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16:00 | | End of session | 

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**Thursday, March 12, 2015**

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Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00
GSMT can run up to four times faster than traditional architectures and have over 51% and 37% reduction in area and power consumption, respectively. Performance of GSMT with different centralized implementations by synthesizing the designs in a 40 nm process. Our experiments show that with 64 clients GSMT that can be configured with five different arbitration policies typically used for shared memory access in real-time systems. (3) We compare the implementation of several predictable arbitration policies. (2) We present an RTL-level implementation of Accounting and Priority assignment (APA) logic of predictable arbitration policies, such as Time Division Multiplexing (TDM) and Round-Robin (RR), are used to provide firm real-time guarantees to clients and avoid its drawbacks. Existing DRAM cache insertion policy blindly forwards victim lines to the off-chip memory, regardless of the potential for increased hits by placing a fraction of them in the DRAM cache; nevertheless, a naïve design that steers all dirty victims to the DRAM cache introduces excessive writeback traffic which aggravates cache misses and DRAM interference. To leverage insertions in terms of writeback or fill requests, we propose a cooperative writeback and insertion policy that adapts to the distinct access patterns of heterogeneous applications based on runtime misses and writeback efficiency, thereby increasing HMIPs (harmonic instruction per cycle) throughput by 22.2%, 17.3% and 14.5% compared to LRU and two static writeback policies.

A GENERIC, SCALABLE AND GLOBALY ARBITRATED MEMORY TREE FOR SHARED DRAM ACCESS IN REAL-TIME SYSTEMS

Predictable arbitration policies, such as Time Division Multiplexing (TDM) and Round-Robin (RR), are used to provide firm real-time guarantees to clients and share a single memory resource (DRAM) between the multiple memory clients in multi-core real-time systems. Traditional centralized implementations of predictable arbitration policies in a shared memory bus or interconnect are not scalable in terms of the number of clients. On the other hand, existing distributed memory interconnects are either globally arbitrated, which do not offer service according to the heterogeneous client requirements, or locally arbitrated, which suffers from a large area, power and latency overhead. Moreover, selecting the right arbitration policy according to the diverse and dynamic client requirements in reusable platforms requires a generic re-configurable architecture supporting different arbitration policies. The main contributions in this paper are: (1) We propose a novel generic, scalable and globally arbitrated memory tree (GSMT) architecture for distributed implementation of several predictable arbitration policies. (2) We present an RTL-level implementation of Accounting and Priority assignment (APA) logic of GSMT that can be configured with five different arbitration policies typically used for shared memory access in real-time systems. (3) We compare the performance of GSMT with different centralized implementations by synthesizing the designs in a 40 nm process. Our experiments show that with 64 clients GSMT can run up to four times faster than traditional architectures and have over 51% and 37% reduction in area and power consumption, respectively.
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Coffee Break 15:30 - 16:00

### 3.5 Breaking Simulation Boundaries

**Date:** Tuesday 10 March 2015  
**Time:** 14:30 - 16:00  
**Location / Room:** Meije

**Chair:** Elena Ioana Vatajelu, Politecnico di Torino, IT  
**Co-Chair:** Florian Letombe, Synopsys, FR

Faster, faster, faster ... that's all you expect when you are simulating your designs. This session takes you through a journey of superfast simulation techniques at different abstraction levels.

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<thead>
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<th>Time</th>
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<th>Presentation Title</th>
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<tbody>
<tr>
<td>14:30</td>
<td>3.5.1</td>
<td>VARIATION-AWARE EVALUATION OF MPSOC TASK ALLOCATION AND SCHEDULING STRATEGIES USING STATISTICAL MODEL CHECKING</td>
</tr>
</tbody>
</table>

**Speakers:**  
Mingsong Chen¹, Daian Yue¹, Xiaoke Qin², Xin Fu³ and Prabhat Mishra²  
¹East China Normal University, CN; ²University of Florida, US; ³University of Houston, US

**Abstract**  
To maximize the overall performance yield, variation-aware analysis is becoming a key step in Multiprocessor System-on-Chip (MPSoc) Task Allocation and Scheduling (TAS). Although various approaches have been investigated to improve performance yields, most of them cannot perform quantitative comparison among existing TAS heuristics, which is important for MPSoc designers to make decisions. Based on the statistical model checker UPPAAL-SMC, we propose a framework that can automatically evaluate the performance yield of TAS strategies under time and power constraints with variations. Experimental results show that our approach can not only filter inferior strategies efficiently, but also support the automated tuning of architecture and constraint parameters to achieve the required performance yield.

Download Paper (PDF; Only available from the DATE venue WiFi)

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</thead>
<tbody>
<tr>
<td>15:00</td>
<td>3.5.2</td>
<td>A FAST PARALLEL SPARSE SOLVER FOR SPICE-BASED CIRCUIT SIMULATORS</td>
</tr>
</tbody>
</table>

**Speaker:** Hehe Li, Department of Electronic Engineering, Tsinghua University, CN  
**Authors:** Xiaoming Chen, Yu Wang and Huazhong Yang, Tsinghua University, CN

**Abstract**  
The sparse solver is a serious bottleneck in SPICE-based circuit simulators. Although several existing researches have proposed some circuit simulation-oriented parallel solvers, there is still some room to improve the speed and scalability of these solvers. This paper proposes a fast parallel sparse solver based on a pivoting-reduction technique which takes full advantage of features of circuit simulation. Experimental results show that on average, the proposed solver is up to 50% faster than the state-of-the-art solver NICSLU, and up to 3.3X faster than KLU. Real DC simulation reveals that our solver is faster than NICSLU, PARDISO, and commercial solvers.

Download Paper (PDF; Only available from the DATE venue WiFi)

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<tbody>
<tr>
<td>15:30</td>
<td>3.5.3</td>
<td>MRP: MIX REAL CORES AND PSEUDO CORES FOR FPGA-BASED CHIP-MULTIPROCESSOR SIMULATION</td>
</tr>
</tbody>
</table>

**Speakers:** Xinkie Chen¹, Guangfei Zhang², Huandong Wang³, Ruiyang Wu¹, Peng Wu¹ and Longbing Zhang¹  
¹Institute of Computing Technology, CAS, CN; ²Shannon Laboratory, Huawei Technologies Co., Ltd, CN; ³Loongson Technology Corporation Limited, CN

**Abstract**  
Facing the speed bottleneck of software-based simulators, FPGA-based simulation has been explored more and more. This paper proposes a novel methodology to simulate a chip-multiprocessor (CMP) on the limited FPGA resource. By mixing real cores and pseudo cores together (MRP), we can simulate a multicore system with fewer FPGA resource requirements and achieve a much higher simulation speed. We propose several methods to construct the pseudo cores. We implement our idea on a dual Virtex-6 FPGA board to simulate a general-purpose 4-core high performance CMP processor. Comparison experiments against the corresponding tape-out chip prove the effectiveness of MRP. We also evaluate MRP prototype’s performance by running SPEC CPU2006 benchmarks on an unmodified Linux operating system, achieving tens to hundreds speedup compared to two other commonly-used simulators.

Download Paper (PDF; Only available from the DATE venue WiFi)
### 3.5.4 SOURCE LEVEL PERFORMANCE SIMULATION OF GPU CORES

**Speakers:**
Christoph Gerum\(^1\), Oliver Bringmann\(^2\) and Wolfgang Rosenstiel\(^1\)
\(^1\)University of Tuebingen, DE; \(^2\)University of Tuebingen / FZI, DE

**Abstract**

Graphic processing units (GPUs) contain a lot of complex architectural features, which make performance analysis and simulation of applications using them for general purpose computations very difficult. Especially when trying to do performance estimation at a higher abstraction level, simulation features for instruction set simulators these features are not handled accurately by state of the art simulation techniques. This paper proposes a method for source level performance simulation of the microarchitecture of a GPU core that provides high enough simulation speed to make testing of large application scenarios cost-effective.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 16:00 IP1-14

#### FAST AND ACCURATE BRANCH PREDICTOR SIMULATION

**Speakers:**
Antoine Faravella, Nicolas Fournil and Frédéric Pétrot, TIMA Laboratory, Université de Grenoble-Alpes/CNRS, FR

**Abstract**

Embedded processors complexity has raised dramatically, due to the addition of architectural add-ons which improve performances significantly. High-level models used in system simulation usually ignore these additions as the major issue is functional correctness. However, accurate estimates of software execution time is sometimes required, therefore we focus in this paper on one of these architectural features, the branch predictor. Unfortunately, advanced branch predictors use large tables, and a direct implementation of the scheme slows down simulation dramatically. To limit the simulation overhead, we define a modeling approach that we demonstrate on a state-of-the-art predictor. We implemented the model in a dynamic binary translation based instruction set simulator and measured an accuracy of prediction of about 95% for a run-time overhead inferior to 5%.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 16:01 IP1-15

#### COMPARATIVE STUDY OF TEST GENERATION METHODS FOR SIMULATION ACCELERATORS

**Speakers:**
Wisam Kadry\(^1\), Dimitry Krestyashyn\(^1\), Arkadiy Morgensthein\(^1\), Amir Nahir\(^1\), Vitali Sokhin\(^1\), Jae Cheol Son\(^2\), Wookyeong Jeong\(^2\), Sung-Boem Park\(^2\) and Jin Sung Park\(^2\)
\(^1\)IBM Research - Haifa, IL; \(^2\)Samsung, KR

**Abstract**

Hardware-accelerated simulation platforms are quickly becoming a major vehicle for the functional verification of modern systems and processors. Accelerator platforms provide functional verification with valuable simulation cycles. Yet, the high cost and limited bandwidth of accelerator platforms dictate a requirement for continuous utilization improvement. In this work, we perform a comparative analysis of two approaches of test generation for accelerator platforms. An exerciser tool is used as experimental vehicle for the study. An off-platform test generation methodology is implemented and is compared to on-platform test generation typically used in exercisers. We present experimental results from simulation of latest IBM POWER8 processor on Avan accelerator platform, as well as from simulation of an eight-core ARMv8-based design on Veloce emulation platform. Our results indicate that the utilization of accelerator platforms can be improved by up to \(+7\) ratio when using off-platform test generation. In addition, increase of up to \(+24\)% is observed in test coverage. Off-platform mode features significantly bigger image size, but maintains tolerable build and load times.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 16:02 IP1-16

#### USING STRUCTURAL RELATIONS FOR CHECKING COMBINATIONALITY OF CYCLIC CIRCUITS

**Speakers:**
Wan-Chen Weng\(^1\), Yung-Chih Chen\(^2\), Jui-Hung Chen\(^1\), Ching-Yi Huang\(^1\) and Chun-Yao Wang\(^1\)
\(^1\)National Tsing Hua University, TW; \(^2\)Yuan Ze University, TW

**Abstract**

Functionality and combinationality are two main issues that have to be dealt with in cyclic combinational circuits, which are combinational circuits containing loops. Cyclic circuits are combinational if nodes within the circuits have definite values under all input assignments. For a cyclified circuit, we have to check whether it is combinational or not. Thus, this paper proposes an efficient two-stage algorithm to verify the combinationality of cyclic circuits. A set of cyclified IWLS 2005 benchmarks are performed to demonstrate the efficiency of the proposed algorithm. Compared to the state-of-the-art algorithm, our approach has a speedup of about 4000 times on average.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 17.30 End of session

Coffee Break in Exhibition Area
Coffee Break in Exhibition Area

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### Lunch Break

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**Tuesday, March 10, 2015**
- Coffee Break 10:30 - 11:30
- Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
- Coffee Break 16:00 - 17:00

**Wednesday, March 11, 2015**
- Coffee Break 10:00 - 11:00
- Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)
- Coffee Break 16:00 - 17:00

**Thursday, March 12, 2015**
- Coffee Break 10:00 - 11:00
- Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
- Coffee Break 15:30 - 16:00
In today's data-intensive applications (known as Big Data problems), such as healthcare (e.g., use of genetic information to diagnose and treat diseases), social media, engineering (e.g. large scientific experiments), the primary goal is to increase the understanding of processes in order to extract so much potential and highly useful information hidden in the huge volume of data, which in turn can be used to increase the productivity. As the speed of information growth exceeds Moore's Law at the beginning of this century, excessive data is making great troubles to human beings. At the same time, Big Data arises with many challenges, such as data capture, data storage, data analysis and data visualization. Performing data analysis within economically affordable time and energy is the pillar to solve big data problems, and therefore extract extremely valuable information. The increase of the data size has already surpassed the capabilities of today’s computation architectures which suffer from communication bottleneck due to limited bandwidth. For instance, the transfer of 1 petabytes data at a rate of 1000MB/second will cost 12.5 days! Communication and memory access does not only kill the performance, but also energy/power (more than between 70% and 90% such applications). Even the CMOS technology used to implement today’s architectures contributes to such power due to the higher leakage; not to mention the limited scalability (as it is becoming very costly), reduced reliability (as it degrades faster), etc. In conclusion, today’s CMOS based architecture are not able to provide the computation capability needed for data-intensive applications. New architectures based new technologies are therefore needed. This Hot-Topic Session will address the concept of “Computing-in-memory (CIM)” and discuss a new Memristor Based Architecture Paradigm for Data-Intensive applications, as an alternative architecture. The concept is based on performing the storage and computation in the same crossbar topology (non Von-Neumann architecture) where the key device is the non-volatile resistive switching element (memristor). CIM architecture is able significantly push the “memory wall”, while the memristor device is able to reduce the static power to practically zero.

<table>
<thead>
<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
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<tr>
<td>14:30</td>
<td>3.6.1</td>
<td>DATA-INTENSIVE APPLICATIONS- A MAJOR CHALLENGE AHEAD</td>
<td>Speaker: Jan van Lunteren, IBM Research, CH</td>
</tr>
<tr>
<td>15:00</td>
<td>3.6.2</td>
<td>CIM ARCHITECTURE- BEYOND VON NEUMANN</td>
<td>Speakers: Koen Bertels$^1$ and Henk Coorporal$^2$</td>
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<td>$^1$Delft University of Technology, NL; $^2$Eindhoven University of Technology, NL</td>
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<tr>
<td>15:30</td>
<td>3.6.3</td>
<td>MEMRISTIVE DEVICES - THE KEY ENabler FOR CIM ARCHITECTURE IMPLEMENTATION</td>
<td>Speaker: Eike Linn, RWTH Aachen University, DE</td>
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<tr>
<td>16:00</td>
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<td>End of session</td>
<td>Coffee Break in Exhibition Area</td>
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<td>Coffee Break in Exhibition Area</td>
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Coffee Break 15:30 - 16:00

3.7 Model-based Analysis and Verification

Date: Tuesday 10 March 2015  
Time: 14:30 - 16:00  
Location / Room: Les Bans  
Chair: Saddek Bensalem, Université Joseph Fourier, FR  
Co-Chair: Linh Thi Xuan Phan, University of Pennsylvania, US  

This session focuses on the analysis and verification in model-based design of embedded systems. It has four regular papers: The first paper presents a delay analysis method for a general graph based workload model. The second one presents a new formal approach to verifying Interrupt-driven software based on symbolic execution. The third one proposes a method for model-based verification (and arguably implementation) of real-time systems, where the original model is expressed as a network of UPPAAL timed automata (PIM). The fourth one presents a generic method to automatically generate a symbolic executor for a given hardware architecture specified by some Architecture Description Language, which is used to verify program properties regarding the binary code level. In this session we have also an IP paper, which presents a technique for estimating non-functional requirements using a Knowledge Discovery in Databases (KDD) approach.
### 3.7.1 Delay Analysis of Structural Real-Time Workload

**Speakers:**
Nan Guan¹, Yue Tang², Yang Wang² and Wang Yi³

¹Uppsala University, SE; ²Northeastern University, CN; ³Uppsala University, CN

**Abstract**
In many complex embedded systems, real-time workload is generated conforming certain structural constraints. In this paper we study how to analyze the delay of real-time workload of which the generation pattern can be modeled by task graphs. We present a platform-agnostic technique in real-time scheduling theory and real-time calculus (RTC) can provide safe delay bounds, but the results are typically over-pessimistic. Then we propose new algorithms to efficiently and precisely solve the delay analysis problem. Experiments with randomly generated task systems are conducted to evaluate the performance of the proposed methods.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 3.7.2 Effective Verification of Low-Level Software with Nested Interrupts

**Speakers:**
Daniel Kroening¹, Li Hao Liang¹, Tom Melham¹, Peter Schwende¹ and Michael Tautschnig²

¹University of Oxford, GB; ²Queen Mary, University of London, GB

**Abstract**
Interrupt-driven software is difficult to test and debug, especially when interrupts can be nested and subject to priorities. Interrupts can arrive at arbitrary times, leading to an explosion in the number of cases to be considered. We present a new formal approach to verifying interrupt-driven software based on symbolic execution. The approach leverages recent advances in the encoding of the execution traces of interacting, concurrent threads. We assess the performance of our method on benchmarks drawn from embedded systems code and device drivers, and experimentally compare it to conventional formal approaches that use source-to-source transformations. Our experimental results show that our method significantly outperforms conventional techniques. To the best of our knowledge, our technique is the first to demonstrate effective formal verification of low-level embedded software with nested interrupts.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 3.7.3 Platform-Specific Timing Verification Framework in Model-Based Implementation

**Speakers:**
Baek Gyu Kim, Lu Feng, Linh T.X. Phan, Oleg Sokolsky and Insup Lee, University of Pennsylvania, US

**Abstract**
In the model-based implementation methodology, the timed behavior of the software is typically modeled independently of the platform-specific timing semantics such as the delay due to scheduling or I/O handling. Although this approach helps to reduce the complexity of the model, it leads to timing gaps between the model and its implementation. This paper proposes a platform-specific timing verification framework that can be used to formally verify the timed behavior of an implementation that has been developed from a platform-independent model. We first describe a way to categorize the interactions among the software, a platform, and the environment in the form of implementation schemes. We then present an algorithm that systematically transforms a platform-independent model into a platform-specific model under a given implementation scheme. This transformation algorithm ensures that the timed behavior of the platform-specific model is close to that of the corresponding implementation. Our case study of an infusion pump system shows that the measured timing delay of the system is bounded by the formally verified bound of its platform-specific model.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 3.7.4 Architecture Description Language Based Retargetable Symbolic Execution

**Speaker:**
Andreas Ibing, TU München, DE

**Abstract**
This paper presents a new formal approach to verifying interrupt-driven software based on symbolic execution. The retargetability is based on an existing open-source processor architecture description language which has been used for processor design and automatic generation of toolchains for dynamic program analysis. The benefit of the presented approach is that with a given architecture description, no manual writing of an instruction set grammar or of a translation of instruction semantics into logics is necessary. The proposed tool architecture relies on language reflection, code generation and dynamic analysis. The benefit of the presented approach is that with a given architecture description, no manual writing of an instruction set grammar or of a translation of instruction semantics into logics is necessary. The proposed tool architecture relies on language reflection, code generation and dynamic loading to retarget symbolic execution to different machine code syntax. Instruction semantics is translated into SMT bit-vector logic equations by symbolically interpreting the architecture description language. The approach is implemented as plug-in extension to the Eclipse IDE and evaluated by automatically detecting integer overflows in binaries for the ARMv5 and SPARCv8 architectures.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 17.00 NFRs Early Estimation Through Software Metrics

**Speakers:**
Andrew Vieira¹, Pedro Faustini¹, Luigi Carro² and Erika Cota³

¹Federal University of Rio Grande do Sul (UFRGS), BR; ²Federal University of Rio Grande do Sul (UFRGS), BR; ³Federal University of Rio Grande do Sul (UFRGS), BR

**Abstract**
We propose the use of regression analysis to generate accurate predictive models for physical metrics using design metrics as input. We validate our approach with 40+ implementations of three systems in two development scenarios: system evolution and first design. Results show maximum prediction errors of 1.66% during system evolution. In a first design scenario, the average error is 15% with the maximum error still below 20% for all physical metrics. This approach provides a fast and accurate strategy to boost embedded software productivity and quality, by estimating Non-Functional Requirements (NFRs) during the first design stages.

Download Paper (PDF; Only available from the DATE venue WiFi)
Coffee Break in Exhibition Area

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### 3.8 Hot Topic - Design Methodologies for a Cyber-Physical Systems Approach to Personalized Medicine-on-a-Chip: Challenges and Opportunities

**Date:** Tuesday 10 March 2015  
**Time:** 14:30 - 16:00  
**Location / Room:** Salle Lesdiguières

**Organiser:**  
Krishnendu Chakrabarty, Duke University, US

**Chair:**  
Paul Pop, Technical University of Denmark, DK

**Co-Chair:**  
Mohammad Abdullah Al Faruque, University of California Irvine, US

Modern stressful and sedentary lifestyles coupled with inadequate, irregular and inappropriate sleep patterns and diet have contributed not only to increased prevalence of chronic diseases but also to increased healthcare costs. To address these emerging clinical and healthcare challenges, in this special session, we advocate for a cross-disciplinary approach to cyber-physical systems design (CPS) aiming at seamlessly and safely integrate sensing, computation, communication, control and actuation for developing new technology for personalized and precise medicine.

#### 14:30  3.8.1 ERROR RECOVERY IN DIGITAL MICROFLUIDICS FOR PERSONALIZED MEDICINE

**Speakers:**  
Mohamed Ibrahim and Krishnendu Chakrabarty, Duke University, US

**Abstract**  
Due to its emergence as an efficient platform for point-of-care clinical diagnostics, design optimization of digital-microfluidic biochips (DMFBs) has received considerable attention in recent years. In particular, error recoverability is of key interest in medical applications due to the need for system reliability. Errors are likely during droplet manipulation due to defects, chip degradation, and the lack of precision inherent in biochemical experiments. We present an illustrative survey on recently proposed techniques for error recovery. The parameters of the error-recovery design space are shown and evaluated for these schemes. Next, we make use of these evaluations to describe how they can guide error recovery in DMFBs. Finally, an experimental case study is presented to demonstrate how an error-recovery scheme can be applied to real-life biochips.

[Download Paper (PDF; Only available from the DATE venue WiFi)](#)

#### 15:00  3.8.2 A CYBER-PHYSICAL SYSTEMS APPROACH TO PERSONALIZED MEDICINE: CHALLENGES AND OPPORTUNITIES FOR NOC-BASED MULTICORE PLATFORMS

**Speaker:**  
Paul Bogdan, University of Southern California, US

**Abstract**  
This paper describes a few fundamental challenges concerning the design of Network-on-Chip (NoC) based multicore as the backbone of cyber-physical systems (CPS) for personalized medicine. One fundamental challenge in designing such CPS architectures is the need for a unifying mathematical description of the dynamical interactions between bio-physiological processes and cyber states. Another fundamental challenge is to build a rigorous mathematical optimization framework that allows the CPS to adapt to varying workloads and demands. To enable large-scale parallelism, we need a rigorous understanding of the CPS workloads that can guide the design and optimization of wired and wireless NoCs. We advocate for the development of goal-oriented self-organization algorithms that seek to both optimize specific design cost functions and maximize information about future system state. It is necessary to identify basic local rules of interaction not only for solving large scale optimization problems in a distributed fashion, but also for inducing an overall degree of autonomy and intelligence in the CPS architecture.

[Download Paper (PDF; Only available from the DATE venue WiFi)](#)
ON-CHIP NETWORK-ENABLED MANY-CORE ARCHITECTURES FOR COMPUTATIONAL BIOLOGY APPLICATIONS

Speakers:
Turbo Majumder¹, Partha Pande² and Ananth Kalyanaraman²

¹Indian Institute of Technology Delhi, IN; ²Washington State University, US

Abstract
Computational molecular biology applications are at the heart of the backend processing in cyber-physical systems when applied to domains such as drug discovery, personalized medicine and genetic disease risk assessment. These applications are characterized by the preponderance of data and computational complexity, and yet require reasonably fast processing in order to have any meaningful impact. As such, hardware acceleration for these applications has generated a lot of research interest. In this paper, we discuss the superiority of Network-on-Chip (NoC)-enabled many-core platforms over other conventional platforms in both the quantum of speedup achieved and the amount of energy consumed. We hence posit that research in NoC-enabled platforms for CPS applications will be a major enabler of future scientific and medical breakthroughs.

Download Paper (PDF; Only available from the DATE venue WiFi)

16:00
End of session
Coffee Break in Exhibition Area
Coffee Break in Exhibition Area

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Coffee Break 15:30 - 16:00
FLARE: A RECONFIGURATION AWARE FLOORPLANNER

Presenter:
Riccardo Cattaneo, Politecnico di Milano, IT

Authors:
Marco Rabozzi and Marco Santambrogio, Politecnico di Milano, IT

Abstract
This demonstration presents a floorplanner tool addressing partially-reconfigurable FPGAs. The input of the tool consists of a set of regions described in terms of their heterogeneous resource requirements with the number of interconnections among regions and the target FPGA of the partial reconfiguration (PR) design. Once the input is specified, the floorplanner allow the designer to manually or automatically perform the floorplan of the regions.

More information ...

SMART CELL DEVELOPMENT PLATFORM FOR EMBEDDED BATTERY MANAGEMENT

Presenter:
Swaminathan Narayanaswamy, TUM CREATE, SG

Authors:
Matthias Kauer, Sebastian Steinhorst, Martin Lukasiewycz and Samarjit Chakraborty

Abstract
Embedded Battery Management (EBM) [1], in contrast to the existing state-of-the-art centralized Battery Management Systems (BMSs) found in Electric Vehicles (EVs) or stationary Electrical Energy Storage (EES) applications, focuses on monitoring and controlling each individual cell of the battery pack with a dedicated Cell Management Unit (CMU). This novel approach of battery management might offer significant advantages over the centralized BMSs, such as higher modularity, plug-and-play integration and shorter time to market. The combination of a battery cell and a CMU forms the smart cell and the system-level functionalities of the EBM are performed in a decentralized manner by the network of smart cells, with the help of the computational and communication resources of CMUs. We present a development platform for such a smart cell enabled EBM. The development platform consists of two components, the hardware platform and the software platform. The hardware platform of the demonstrator comprises of battery cells and their dedicated CMUs which consist of a smart cell controller board and an active cell balancing board. The software platform provides the smart cell firmware as well as a software tool for verification of active cell balancing architectures and a smart cell simulator for simulating system-level EBM functionalities.

More information ...

OSTC: COMBINING HIFSUITE AND SCNSL FOR SMART DEVICE INTEGRATION AND SIMULATION

Presenter:
Graziano Pravadelli, University of Verona, IT

Authors:
Alessandro Danese, Franco Fummi, Valerio Guarnieri, Michele Lora, Graziano Pravadelli and Francesco Stefanni, University of Verona, IT

Abstract
The main design system of issues are their high degree of heterogeneity, due to the simultaneous presence of multiple domains and extra-functional properties, together with the traditional system functionality. This makes design and simulation very challenging, even because heterogeneity implies that the functionality is not the only dimension that must be considered at validation time. Other properties, such as power consumption or thermal dissipation, are critical to ensure correctness of the final product and to correctly estimate its behavior. This makes component integration and simulation key phases in the design and verification process of smart devices. Thus, to efficiently master smart device design, it is fundamental to be aware of design issues and to know how to solve them through innovative tools and methods, which allow integrating all the components of a smart device into an efficient and flexible simulation platform. We addressed such issues by means of the combined use of HIFSuite tools and SCNSL to obtain a homogeneous and fast SystemC/C++ model of a device through the compositions of heterogeneous components. An Open Source Test Case (OSTC) has been defined to show the potentiality of the proposed methods and tools.

More information ...

IMPLEMENTATIONS OF THE SEMI-GLOBAL MATCHING 3D VISION ALGORITHM FOR AUTOMOTIVE APPLICATIONS

Presenter:
Affaq Qamar, Politecnico di Torino, IT

Author:
Luciano Lavagno, Politecnico di Torino, IT

Abstract
The main will show our real-time hardware implementations on a Xilinx® ZynqTM System-on-Chip of the Semi-Global Matching (SGM) algorithm, which is frequently used in stereo vision systems, e.g. for automotive applications. We will also compare the quality of results, flexibility and design time that we achieved using both High-Level Synthesis (HLS) and manual RTL design. The use of HLS is particularly promising because the automotive industry is very sensitive to production costs, hence it requires various implementations of the same algorithm, with very different resolutions, costs, and performance levels, for different target market segments. SGM mainly consists of three sequential processing steps which are, (i) cost cube calculation, (ii) path cost computation and (iii) disparity estimation and minimization. The path cost computation further involves processing of pixel wise cost cube data into eight distinct directions. The initial algorithmic “golden” model used very large arrays, which had to be mapped to an external DRAM and brought into the on-chip RAM of the FPGA on demand. This required both adding the memory transfer loops and inserting calls to the AXI transactors that access the DRAM through the on-chip DDR slave. Moreover, the initial single-threaded algorithm had to be parallelized, by converting the top-level sweeps of the image in eight directions into forward and backward passes. Both manual RTL and HLS designs were suitable to achieve the target real-time performance. The design space was thus explored by making several fairly different micro-architectural choices. In the end, it was possible to obtain an implementation which is comparable to the manual RTL design. The authors intend to demonstrate the FPGA based HW implementation of the SGM algorithm (upon permission from the industrial partners) and discuss the HLS flow and comparison strategy.

More information ...

RECONFIGURABLE FPGA-BASED NON-INTRUSIVE BERT FOR PRODUCTION TEST

Presenter:
Sergei Odinotsyov, Tallinn University of Technology, EE

Author:
Artjom Jasnetski, Tallinn University of Technology, EE

Abstract
We introduce an FPGA-based Bit Error Rate (BER) tester solution for high-speed serial links targeting production environment. This solution does not require usage of external T&M equipment or extra DFT. As opposed to intrusive physical probing with external BER tester our approach produces more relevant output because measurement is done using transceivers in their functional mode. Introduced BERT instrument supports fine tuning of link parameters and pattern generation. This solution can replace long lasting BER test by quick evaluation of link quality using eye diagram.

More information ...

XTSI: THE 3-D ELECTRO-THERMAL SIMULATOR

Presenter:
Jürgen Scheible, Reutlingen University, DE

Author:
Carl Christoph Jung, Reutlingen University, DE

Abstract
xtSi is a 3D electro-thermal simulation tool for integrated circuits. It uses a computationally efficient algorithm, which allows the simulation of typical ICs in only a few minutes. The temperature distribution is depicted graphically and with temporal resolution in a specially designed graphical user interface. With the help of xtSi designers can exactly identify isotherms and hotspots, thus enabling an optimization of the layout due to temperature effects. xtSi has been verified experimentally for device temperatures exceeding 500 °C up to the onset of thermal runaway.

More information ...
**ODEN: ASSERTION MINING FOR BEHAVIORAL DESCRIPTIONS**

Presenter: Alessandro Danese, University of Verona, IT

Authors: Alessandro Danese, Tara Ghasempouri and Graziano Pravadelli, University of Verona, IT

Abstract

Specification mining is an automatic approach for extracting assertions from the implementation of the system under verification (SUV). Its primary goal is to improve the verification and documentation process by allowing the user to perform a reasoning process about the expected behavior of the system. ODEN works on a wider range of abstraction levels (e.g., gate-level, RTL, TLM, SW level, ...) and it considers a wider set of temporal patterns to more precisely characterize the behaviors of the SUV.

More information ...

**17:30 End of session**

### IP1 Interactive Presentations

**Date:** Tuesday 10 March 2015  
**Time:** 16:00 - 16:30  
**Location / Room:** Exhibition Area

Interactive Presentations run simultaneously during a 30-minute slot. A poster associated to the IP paper is on display throughout the afternoon. Additionally, each IP paper is briefly introduced in a one-minute presentation in a corresponding regular session, prior to the actual Interactive Presentation. At the end of each afternoon Interactive Presentations session the award 'Best IP of the Day' is given.

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<td>HIGH-RESOLUTION ONLINE POWER MONITORING FOR MODERN MICROPROCESSORS</td>
<td>Fabian Obrinl, Jos Ewert and Mehdi Tahoori, Karlsruhe Institute of Technology, DE</td>
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<td>IP1-2</td>
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<td>Andres Gomez(^1), Christian Pinto(^2), Andrea Bartolini(^1), Davide Rossi(^2), Hamed Fatemi(^4), Jose Pineda de Gyvez(^4) and Luca Benini(^5)</td>
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<td>Mahdi Jelodari Mamaghani, Jim Garside and Doug Edwards, University of Manchester, GB</td>
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<td>AUTOMATED FEATURE LOCALIZATION FOR DYNAMICALLY GENERATED SYSTEMC DESIGNS</td>
<td>Jannis Stoppe(^1), Robert Ville(^1) and Rolf Drechsler(^2)</td>
</tr>
</tbody>
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\(^1\)Swiss Federal Institute of Technology in Zurich (ETHZ), CH;  
\(^2\)Università di Bologna, IT;  
\(^3\)Università di Bologna, IT / ETH Zurich, CH;  
\(^4\)NXP Semiconductors, NL;  
\(^5\)Università di Bologna / Swiss Federal Institute of Technology in Zurich (ETHZ), IT

Download Paper (PDF; Only available from the DATE venue WiFi)
**[I-P1-5]** INDUCTOR OPTIMIZATION FOR ACTIVE CELL BALANCING USING GEOMETRIC PROGRAMMING

**Speakers:**
Matthias Kauer¹, Swaminathan Narayanaswamy¹, Martin Lukasiiewycz¹, Sebastian Steinhorst¹ and Samarjit Chakraborty²

**1TU Munich, DE; 2TU Munich, DE**

**Abstract**
This paper proposes an optimization methodology for inductor components in active cell balancing architectures of electric vehicle battery packs. For this purpose, we introduce a new mathematical model to quantitatively describe the charge transfer of a family of inductor-based circuits. Utilizing worst case assumptions, this model yields a nonlinear program for designing the inductor and selecting the transfer current. In the next step, we transform this problem into a geometric program that can be efficiently solved. The optimized inductor reduces energy dissipation by at least 20% in various scenarios compared to a previous approach which selected an optimal off-the-shelf inductor.

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**[I-P1-6]** LIGHTWEIGHT AUTHENTICATION FOR SECURE AUTOMOTIVE NETWORKS

**Speakers:**
Philipp Mundhenk¹, Sebastian Steinhorst¹, Martin Lukasiiewycz¹, Suhab A. Fahmy² and Samarjit Chakraborty³

**1TU Munich, DE; 2School of Computer Engineering, Nanyang Technological University, SG; 3TU Munich, DE**

**Abstract**
We propose a framework to bridge the gap between secure authentication in automotive networks and on the internet. Our proposed framework allows runtime key exchanges with minimal overhead for resource-constrained in-vehicle networks. It combines symmetric and asymmetric cryptography to establish secure communication and enable secure updates of keys and software throughout the lifetime of the vehicle. For this purpose, we tailor authentication protocols for devices and authorization protocols for streams to the automotive domain. As a result, our framework natively supports multicast and broadcast communication. We show that our lightweight framework is able to initiate secure message streams over 15 times faster than conventional frameworks, for the first time meeting the real-time requirements of automotive networks.

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**[I-P1-7]** MINIMIZING THE NUMBER OF PROCESS CORNER SIMULATIONS DURING DESIGN VERIFICATION

**Speakers:**
Michael Shiniker, Bruce Cockburn, Jie Han and Witold Pedrycz, University of Alberta, CA

**Abstract**
Integrated circuit designs need to be verified in simulation over a large number of process corners that represent the expected range of transistor properties, supply voltages, and die temperatures. Each process corner can require substantial simulation time. Unfortunately, the required number of corners has been growing rapidly in the latest semiconductor technologies. We consider the problem of minimizing the required number of process corner simulations by iteratively learning a model of the output functions in order to confidently estimate key maximum and/or minimum properties of those functions. Depending on the output function, the required number of corner simulations can be reduced by factors of up to 95%.

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**[I-P1-8]** AN APPROXIMATE VOTING SCHEME FOR RELIABLE COMPUTING

**Speakers:**
Ke Chen¹, Jie Han² and Fabrizio Lombardi³

1Northeastern University, US; 2University of Alberta, CA

**Abstract**
This paper relies on the principles of inexact computing to alleviate the issues arising in static masking by voting for reliable computing. A scheme that utilizes approximate voting is proposed; it is referred to as inexact double modular redundancy (IDMR). IDMR does not resort to triplication, thus saving overhead due to modular replication; moreover, this scheme is adaptive in its operation, i.e., it allows a threshold to determine the validity of the module outputs. IDMR operates by initially establishing the difference between the values of the outputs of the two modules; only if the difference is below a preset threshold, then the voter calculates the average value of the two module outputs. An extensive analysis of the voting circuits and an application to image processing are presented.

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**[I-P1-9]** FLINT: LAYOUT-ORIENTED FPGA-BASED METHODOLOGY FOR FAULT TOLERANT ASIC DESIGN

**Speakers:**
Rochus Nowosielski, Lukas Gerlach, Stephan Biebhand, Guillermo Paya-Vaya and Holger Blume, Leibniz Universität Hannover, Institute of Microelectronic Systems, DE

**Abstract**
Research of efficient fault tolerance techniques for digital systems requires insight into the fault propagation mechanism inside the ASIC design. Radiation, high temperature, or charge sharing effects in ultra-deep submicron technologies influence fault generation and propagation dependent on die location. The proposed methodology links efficient fault injection to fault propagation in the floorplan view of a standard cell ASIC. This is achieved by instrumentation of the gate netlist after place&route, emulation in an FPGA system and experiment control via interactive user interface. Further, automated fault injection campaigns allow exhaustive fault tolerance evaluations taking single faults as well as adjacent cell faults into account. The proposed methodology can be used to identify vulnerable cell nodes in the design and allow the classification of placement strategies of fault tolerant ASIC designs.

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**[I-P1-10]** A UNIFIED HARDWARE/SOFTWARE MPSoC SYSTEM CONSTRUCTION AND RUN-TIME FRAMEWORK

**Speakers:**
Sam Skalicky¹, Andrew Schmidt², Matthew French² and Sonia Lopez¹

¹Rochester Institute of Technology, US; ²USC/ISI, US

**Abstract**
With the continual enhancement of heterogeneous resources in FPGA devices, utilizing these resources becomes a challenging burden for developers. Especially with the inclusion of sophisticated multiple processor system-on-chips, the necessary skill set to effectively leverage these resources spans both hardware and software expertise. The maturation of high level synthesis tools and programming languages aims to alleviate these complexities, yet there still exist systematic gaps that must be bridged to provide a more cohesive hardware/software development environment. High level MPSoC design initiatives such as Redsharc have reduced the costs of entry, simplifying application implementation. We propose a unified hardware/software framework for system construction, leveraging Redsharc’s APIs, efficient on-chip interconnects, and run-time controllers. We present system level abstractions that enable compilation and implementation tools for hardware and software to be merged into a single configurable system development environment. Finally, we demonstrate our proposed framework with Redsharc, using AES encryption/decryption spanning software implementations on ARM and MicroBlaze processors and hardware kernels.

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**Speakers:** Shakith Fernando1, Mark Wijdeveld1, Cedric Nugteren1, Akash Kumar2 and Henk Corporaal 3

1Eindhoven University of Technology, NL; 2National University of Singapore, SG; 3TU/e (Eindhoven University of Technology), NL

**Abstract**

Hardware accelerators in heterogeneous multiprocessor system-on-chips are becoming popular as a means of meeting performance and energy efficiency requirements. In modern embedded synthesis, such as High-Level Synthesis, they are not fully automated. Therefore, time-consuming manual iterations are required to explore efficient accelerator alternatives: the programmer is still required to think in terms of the underlying architecture. In this paper, we present (AS)^2: a design flow for Accelerator Synthesis using Algorithmic Skeletons. Skeletonization separates the structure of a parallel computation from an algorithms' functionality, enabling efficient implementations without requiring the programmer to have hardware knowledge. We define three such skeletons (for three image processing kernels), enabling FPGA specific parallelization techniques and optimizations. As a case study, we present a design space exploration of these skeletons and show how multiple design points with area-performance trade-offs, for the accelerators, can be efficiently and rapidly synthesized. We show that (AS)^2 is promising direction for accelerator synthesis as it generates a Pareto front of 8 design points in under half an hour, for each of the three image processing kernels.

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[PI-12] **ASSISTED GENERATION OF FRAME CONDITIONS FOR FORMAL MODELS**

**Speakers:** Philipp Niemann, Frank Hilken, Martin Gogolla and Robert Wille, University of Bremen, DE

**Abstract**

Modeling languages such as UML or SysML allow for the validation and verification of the structure and the behavior of designs even in the absence of a specific implementation. However, formal models inherit a severe drawback: Most of them hardly provide a comprehensive and determinate description of transitions from one system state to another. This problem can be addressed by additionally specifying so-called frame conditions. However, only naïve "workarounds" based on trivial heuristics or completely relying on a manual creation have been proposed for their generation thus far. In this work, we aim for a solution which neither leaves the burden of generating frame conditions entirely on the designer (avoiding the introduction of another time-consuming and expensive design step) nor is completely automatic (which, to ambiguities, is not possible anyway). For this purpose, a systematic design methodology for the assisted generation of frame conditions is proposed.

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[PI-13] **TOWARDS A META-LANGUAGE FOR THE CONCURRENCY CONCERN IN DSLS**

**Speakers:** Julien Deantoni1, Papa Iasa Diallo2, Ciprian Teodorov2, Joel Champeau2 and Benoît Combemale3

1I3S, University of Nice Sophia Antipolis, FR; 2Lab-STICCC - ENSTA Bretagne, FR; 3I3S, University of Rennes1, FR

**Abstract**

Concurrency is of primary interest in the development of complex software-intensive systems, as well as the deployment on modern platforms. Furthermore, Domain-Specific Languages (DSLs) are increasingly used in industrial processes to separate and abstract the various concerns of complex systems. However, reifying the definition of the DSL concurrency remains a challenge. This not only prevents leveraging the concurrency concern of a particular domain or platform, but it also hinders: (1) the development of a complete understanding of the DSL semantics; (2) the effectiveness of concurrency-aware analysis techniques; (3) the analysis of the deployment on parallel architectures. However, the approach we introduce for the key ideas leading toward MoCCML, a dedicated meta-language for formally specifying the concurrency concern within the definition of a DSL. The concurrency constraints can reflect the knowledge in a particular domain, but also the constraints of a particular platform. MoCCML comes with a complete language workbench to help a DSL designer in the definition of the concurrency directly within the concepts of the DSL itself, and a generic workbench to simulate and analyze any model conforming to this DSL. MoCCML is illustrated on the definition of a lightweight extension of SDF (Synchronous Data Flow).

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[PI-14] **FAST AND ACCURATE BRANCH PREDICTOR SIMULATION**

**Speakers:** Antoine Faravelon, Nicolas Fournel and Frédéric Pérot, TIMA Laboratory, Université de Grenoble-Alpes/CRNS, FR

**Abstract**

Embedded processors complexity has raised dramatically, due to the addition of architectural add-ons which improve performances significantly. High level models used in system simulation usually ignore these additions as the major issue is functional correctness. However, accurate estimates of software execution is sometimes required, therefore we focus in this paper on one of these architectural features, the branch predictor. Unfortunately, advanced branch predictors use large tables, and a direct implementation of the scheme slows down simulation dramatically. To limit the simulation overhead, we define a modeling approach that we demonstrate on a state-of-the-art predictor. We implemented the model in a dynamic binary translation based instruction set simulator and measured an accuracy of prediction of about 95% for a run-time overhead inferior to 5%.

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[PI-15] **COMPARATIVE STUDY OF TEST GENERATION METHODS FOR SIMULATION ACCELERATORS**

**Speakers:** Wisam Kadry1, Dimitry Krestyashyn1, Arkadiy Morgenstern1, Amir Nahr1, Vitali Sokhin1, Jae Cheol Son2, Wookyeong Jeong2, Sung-Boem Park2 and Jin Sung Park2

1IBM Research - Haifa, IL; 2Samsung, KR

**Abstract**

Hardware-accelerated simulation platforms are quickly becoming a major vehicle for the functional verification of modern systems and processors. Accelerator platforms provide functional verification with valuable simulation improvements. Yet, the high cost and limited bandwidth of accelerator platforms dictate a requirement for continuous utilization improvement. In this work, we perform a comparative analysis of two approaches of test generation for accelerator platforms. An exerciser tool is used as experimental vehicle for the study. An off-platform test generation methodology is implemented and is compared to on-platform test generation typically used in exercisers. We present experimental results from simulation of latest IBM POWER8 processor on Awlan accelerator platform, as well as from simulation of an eight-core ARMv8-based design on Veloci emulation platform. Our results indicate that the utilization of accelerator platforms can be improved by up to x7 ratio when using off-platform test generation. In addition, increase of up to 24% is observed in test coverage. Off-platform mode features significantly bigger image size, but maintains tolerable build and load times.

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[PI-16] **USING STRUCTURAL RELATIONS FOR CHECKING COMBINATIONALITY OF CYCLIC CIRCUITS**

**Speakers:** Wan-Chen Weng1, Yung-Cih Chen1, Jui-Hung Chen1, Ching-Yi Huang1 and Chun-Yao Wang1

1National Tsing Hua University, TW; 2Yuan Ze University, TW

**Abstract**

Functionality and combinationality are two main issues that have to be dealt with in cyclic combinational circuits, which are combinational circuits containing loops. Cyclic circuits are combinational if nodes within the circuits have definite values under all input assignments. For a cyclic circuit, we have to check whether it is combinational or not. Thus, this paper proposes an efficient two-stage algorithm to verify the combinationality of cyclic circuits. A set of cyclefied IWLS 2005 benchmarks are performed to demonstrate the efficiency of the proposed algorithm. Compared to the state-of-the-art algorithm, our approach has a speedup of about 40000 times on average.

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NFRS EARLY ESTIMATION THROUGH SOFTWARE METRICS

Speakers:
Andrws Vieira¹, Pedro Faustini¹, Luigi Carro² and Erika Cota¹
¹Federal University of Rio Grande do Sul (UFRGS), BR; ²Federal University of Rio Grande do Sul (UFRGS), BR

Abstract
We propose the use of regression analysis to generate accurate predictive models for physical metrics using design metrics as input. We validate our approach with 40+ implementations of three systems in two development scenarios: system evolution and first design. Results show maximum prediction errors of 1.66% during system evolution. In a first design scenario, the average error is 15% with the maximum error still below 20% for all physical metrics. This approach provides a fast and accurate strategy to boost embedded software productivity and quality, by estimating Non-Functional Requirements (NFRs) during the first design stages.

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4.1 Executive Panel - Trends and Challenges in Today’s Automotive Semiconductors

Date: Tuesday 10 March 2015
Time: 17:00 - 18:30
Location / Room: Salle Oisans
Organiser:
Yervant Zorian, Fellow & Chief Architect, Synopsys, US
Moderator:
Chris Edwards, Tech Design Forum / E&T, GB

While the new chips in the automotive industry keep growing both in functionality and numbers, the complexity level and robustness requirements remain crucial, as always, given their safety critical application. The speakers in this executive session will address the current trends and challenges in the automotive semiconductor industry.

Panelists:
- Andreas Brüning, ZMDI, DE
- Maurizio Peri, STMicroelectronics, IT
- Jean-Marie Saint-Paul, Mentor, FR
- Frank Schirrmeister, Cadence Design Systems, US

18:30 End of session

4.2 Implementation and Verification of Security Components

Date: Tuesday 10 March 2015
Time: 17:00 - 18:30
Location / Room: Belle Etoile
Chair:
Francesco Regazzoni, AlaRI, CH
Co-Chair:
Georg Becker, RUB, DE

System designers need secure building blocks for robust security devices. This session presents novel implementation and verification strategies for hardware circuits, post-quantum cryptography schemes and true random number generators.

<table>
<thead>
<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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| 17:00 | 4.2.1 | PRIVACY-PRESERVING FUNCTIONAL IP VERIFICATION UTILIZING FULLY HOMOMORPHIC ENCRYPTION | Charalampos Konstantinou¹ and Michail Maniatakos²
¹New York University Polytechnic School of Engineering, US; ²New York University Abu Dhabi, AE |

Abstract
Intellectual Property (IP) verification is a crucial component of System-on-Chip (SoC) design in the modern IC design business model. Given a globalized supply chain and an increasing demand for IP reuse, IP theft has become a major concern for the IC industry. In this paper, we address the trust issues that arise between IP owners and IP users during the functional verification of an IP core. Our proposed scheme ensures the privacy of IP owners and users, by a) generating a privacy-preserving version of the IP, which is functionally equivalent to the original design, and b) employing homomorphically encrypted input vectors. This allows the functional verification to be securely outsourced to a third-party, or to be executed by either parties, while revealing the least possible information regarding the test vectors and the IP core. Experiments on both combinational and sequential benchmark circuits demonstrate up to three orders of magnitude IP verification slowdown, due to the computationally intensive fully homomorphic operations, for different security parameter sizes.

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<th>Time</th>
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<tr>
<td>17:30</td>
<td>4.2.2</td>
<td>EFFICIENT SOFTWARE IMPLEMENTATION OF RING-LWE ENCRYPTION</td>
<td>Ruan de Clercq, Sujoy Sinha Roy, Frederik Vercauteren and Ingrid Verbauwhede, KU Leuven - COSIC, BE</td>
</tr>
</tbody>
</table>

Abstract
Present-day public-key cryptosystems such as RSA and Elliptic Curve Cryptography (ECC) will become insecure when quantum computers become a reality. This paper presents the new state of the art in efficient software implementations of a post-quantum secure public-key encryption scheme based on the ring-LWE problem. We use a 32-bit ARM Cortex-M4F microcontroller as the target platform. Our contribution includes optimization techniques for fast discrete Gaussian sampling and efficient polynomial multiplication. Our implementation beats all known software implementations of ring-LWE encryption by a factor of at least 7. We further show that our scheme beats ECC-based public-key encryption schemes by at least one order of magnitude. At medium-term security we require 121166 cycles per encryption and 43324 cycles per decryption, while at a long-term security we require 261939 cycles per encryption and 96520 cycles per decryption. Gaussian sampling is done at an average of 28.5 cycles per sample.

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synthesize satisfiability modulo theories (SMT)-based systems. multi-core processors, where hotspot is a critical issue, for improving reliability and lifetime. The third talk effectively combines logic solver and background theory solver to switching method in multi-core scheduling problem for efficient power saving under throughput constraint. The second talk studies thermal-pattern-aware task assignment for 3D Multi-/Manycore Scheduling

4.3.2

EMBEDDED HW/SW PLATFORM FOR ON-THE-FLY TESTING OF TRUE RANDOM NUMBER GENERATORS

Speakers:
Bohan Yang1, Vladimir Rozic1, Nele Mentens2, Wim Dehaene2 and Ingrid Verbauwhede3
1ESAT/COSIC and iMinds, CU Leuven, BE; 2ESAT-MICAS, CU Leuven, BE; 3CU Leuven - COSIC, BE

Abstract
We present a HW/SW platform for on-the-fly detection of failures and weaknesses in entropy sources. By splitting the operations between hardware and software, we achieve sufficient flexibility to control the level of significance of the tests. This approach also enables sharing resources between different tests thereby reducing the area and power. Statistical tests were selected from the NIST test suite. We propose several versions of hardware co-processors for monitoring random bit sequences, ranging from 52 slices (5 tests) to 552 slices (9 tests) on Spartan-6 FPGA. We are the first to provide implementations of the Serial test and the Approximate entropy test for on-the-fly monitoring.

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4.3.3

COMPARISON OF MULTI-PURPOSE CORES OF KECCAK AND AES

Speakers:
Panasaavya Yalla, Ekawat Homesiriakom and Jens-Peter Kaps, George Mason University, US

Abstract
Most widely used security protocols, Internet Protocol Security (IPSec), Secure Socket Layer (SSL), and Transport Layer Security (TLS), provide several cryptographic services which in turn require multiple dedicated cryptographic algorithms. A single cryptographic primitive for all secret key functions utilizing different mode of operations can overcome this constraint. This paper investigates the possibility of using AES and Keccak as the underlying primitives for high-speed and resource constrained applications. Even though a plain AES implementation is typically much smaller and has a better throughput to area ratio than a plain Keccak, adding additional cryptographic services changes the results dramatically. Our multi-purpose Keccak outperforms our multi-purpose AES by a factor of 4 for both throughput and area on average. This underlines the flexibility of the Keccak Sponge and Duplex functions. Our multi-purpose Keccak achieves a throughput of 23.2 Gbps in AE-mode (Keyak) on a Xilinx Virtex-7 and 28.7 Gbps on a Altera Stratix-IV. In order to study this further we also implemented two versions of a dedicated Keyak and dedicated AES-GCM. Our dedicated Keyak implementation outperforms our dedicated AES-GCM on average by a factor 6 in terms of throughput over area reaching a throughput of 28.9 Gbps and 4.1 Gbps respectively on a Xilinx Virtex-7.

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End of session

4.3 Multi-/Manycore Scheduling

Date: Tuesday 10 March 2015

Time: 17:00 - 18:30

Location / Room: Stendhal

Chair:
Luciano Lavagno, Politecnico di Torino, IT

Co-Chair:
Aviral Shivastava, Arizona State University, US

This session tackles various issues in realistic, complex task scheduling/assignment methods in 3D and 3D multi/many-core systems. The first talk introduces an intra/inter-cores switching method in multi-core scheduling problem for efficient power saving under throughput constraint. The second talk studies thermal-pattern-aware task assignment for 3D multi-core processors, where hotspot is a critical issue, for improving reliability and lifetime. The third talk effectively combines logic solver and background theory solver to synthesize satisfiability modulo theories (SMT)-based systems.

4.3.1

AN ONLINE THERMAL-CONSTRAINED TASK SCHEDULER FOR 3D MULTI-CORE PROCESSORS

Speakers:
Chien-Hui Liao1, Hung-Pin Wen1 and Krishnendu Chakrabarty2
1National Chiao Tung University, TW; 2Duke University, US

Abstract
Hotspots occur frequently in 3D multi-core processors (3D-MCPs) and they can adversely impact system reliability and lifetime. Moreover, frequent occurrences of hotspots lead to more dynamic voltage and frequency scaling (DVFS), resulting in degraded throughput. Therefore, a new thermal-constrained task scheduler based on thermal-pattern-aware voltage assignment (TPAVA) is proposed in this paper. By analyzing temperature profiles of different voltage assignments, TPAVA pre-emptively assigns different operating-voltage levels to cores for reducing temperature increase in 3D-MCPs. Moreover, the proposed task scheduler integrates a vertical-grouping voltage scaling (VGVS) strategy that considers thermal correlation in 3D-MCPs. Experimental results show that, compared with two previous methods, the proposed task scheduler can respectively lower hotspot occurrences by 47.13% and 53.91%, and improve throughput by 6.50% and 32.06%. As a result, TPAVA and VGVS are effectively for reducing occurrences of hotspots and optimizing throughput under thermal constraints.

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4.3.2

A SYMBOLIC SYSTEM SYNTHESIS APPROACH FOR HARD REAL-TIME SYSTEMS BASED ON COORDINATED SMT-SOLVING

Speakers:
Alexander Biewer1, Benjamin Andres1, Jens Gladigau2 and Christian Haubelt3
1Robert Bosch GmbH, DE; 2University of Potsdam, DE; 3University of Rostock, DE

Abstract
We propose an SMT-based system synthesis approach where the logic solver performs static binding and routing while the background theory solver computes global time-triggered schedules. In contrast to previous work, we assign additional time to the logic solver in order to refine the binding and routing such that the background theory solver is more likely to find a feasible schedule within a reasonable amount of time. We show how experiments that can be performed only with the current set of constraints are applicable.

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4.3.3

E-PIPELINE: ELASTIC HARDWARE/SOFTWARE PIPELINES ON A MANY-CORE FABRIC

Speakers:
Xi Zhang1, Haris Javaid1, Muhammad Shafique1, Jorgen Peddersen1, Joeg Henkel2 and Sri Parameswaran1
1University of New South Wales, AU; 2Karlsruhe Institute of Technology (KIT), DE

Abstract
On-chip many-core systems are expected to be in common use in the future. A set of homogeneous processors in a many-core system can be used to implement multiple pipelines which execute simultaneously. Pipelines of processors use varying numbers of cores when their workloads vary at run time. In this paper, we show how such a system executing multiple pipelines with varying workloads can be implemented. We further show how the system can switch cores within a pipeline (intra-elasticity) and between pipelines (inter-elasticity). The method is named E-pipeline, and is implemented and evaluated in a commercial tool suite. Compared to reference design methods with clock gating, E-pipeline achieves the same power savings, maintains the throughput to meet throughput constraints and reduces core usage by an average of 37.7%. The adaptation overhead for switching cores is approximately 2 us.

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4.4 Exploring Reliability and Efficiency Tradeoffs at the Architectural Level

Date: Tuesday 10 March 2015
Time: 17:00 - 18:30
Location / Room: Chartreuse

Chair: Todd Austin, University of Michigan, US
Co-Chair: Gunar Schirner, Northeastern University, US

This session targets architectural solutions for energy-efficient and reliable memories and processors.

17:00  4.4.1 SOFT-ERROR RELIABILITY AND POWER CO-OPTIMIZATION FOR GPGPU REGISTER FILE USING RESISTIVE MEMORY
Speakers:
Jingweijia Tan1, Zhi Li2 and Xin Fu2
1University of Houston, US; 2University of Kansas, US

Abstract
The increasing adoption of graphics processing units (GPUs) for high-performance computing raises the reliability challenge, which is generally ignored in traditional GPUs. GPUs usually support thousands of parallel threads and require a sizable register file. Such large register file is highly susceptible to soft errors and power-hungry. Although ECC has been adopted to register file in modern GPUs, it causes considerable power overhead, which further increases the power stress. Thus, an energy-efficient soft-error protection mechanism is more desirable. Besides its extremely low leakage power consumption, resistive memory (e.g. spin-transfer torque RAM) is also immune to the radiation induced soft errors due to its magnetic field based storage. In this paper, we propose to leverage resistive memory to enhance the soft-error robustness and reduce the power consumption (LESS) of registers in the General-Purpose computing on GPUs (GPGPUs). Since resistive memory experiences longer write latency compared to SRAM, we explore the unique characteristics of GPGPU applications to obtain the win-win gains: achieving the near-full soft-error protection for the register file, and meanwhile substantially reducing the energy consumption with negligible performance loss. Our experimental results show that LESS is able to mitigate the registers soft-error vulnerability by 86% and achieve 60% energy savings with negligible (e.g. 4%) performance loss.

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17:30  4.4.2 ENERGY-EFFICIENT CACHE DESIGN IN EMERGING MOBILE PLATFORMS: THE IMPLICATIONS AND OPTIMIZATIONS
Speakers:
Kaige Yan and Xin Fu, University of Houston, US

Abstract
Mobile devices are quickly becoming the most widely used processors in consumer devices. Since their major power supply is battery, the energy-efficient computing is highly desired. In this paper, we focus on the energy-efficient cache design in emerging mobile platforms. We observe that more than 40% of L2 cache accesses are OS kernel accesses in interactive smartphone applications. Such frequent kernel accesses cause serious interference between the user and kernel blocks in the L2 cache, leading to the unnecessary block replacements and high L2 cache miss rate. We propose to partition the L2 cache into two separate segments which can only be accessed by the user code and kernel code, respectively. Meanwhile, the overall size of the two segments is shrunk, which greatly reduces the energy consumption by 15% while still maintains the similar cache miss rate. We further find completely different access behaviors between the two separated kernel and user segments in our novel L2 cache design, and explore the multi-retention STT-RAM based user and kernel segments to maximize the cache energy savings. The experimental results show that our techniques significantly reduce the cache energy consumption (e.g. 75%) with only 2% performance loss in emerging smartphones.

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18:00  4.4.3 EXPLOITING DYNAMIC TIMING MARGINS IN MICROPROCESSORS FOR FREQUENCY-OVER-SCALING WITH INSTRUCTION-BASED CLOCK ADJUSTMENT
Speakers:
Jeremy Constantin1, Lai Wang2, Georgios Karakonstantis1, Anupam Chattopadhyay and Andreas Burg1
1École Polytechnique Fédérale de Lausanne (EPFL), CH; 2RWTH Aachen, DE; 3Queen's University, GB

Abstract
Static timing analysis provides the basis for setting the clock period of a microprocessor core, based on its worst-case critical path. However, depending on the design, this critical path is not always excited and therefore dynamic timing margins exist that can theoretically be exploited for the benefit of better speed or lower power consumption (through voltage scaling). This paper introduces predictive instruction-based dynamic clock adjustment as a technique to trim dynamic timing margins in pipelined microprocessors. To this end, we exploit the different timing requirements for individual instructions during the dynamically varying program execution flow without the need for complex circuit-level measures to detect and correct timing violations. We provide a design flow to extract the dynamic timing information for the design using post-layout dynamic timing analysis and we integrate the results into a custom cycle- accurate simulator. This simulator allows annotation of individual instructions with their impact on timing (in each pipeline stage) and rapidly derives the overall code execution time for complex benchmarks. The design methodology is illustrated at the microarchitecture level, demonstrating the performance and power gains possible on a 6-stage OpenRISC in-order general purpose processor core in a 28 nm CMOS technology. We show that employing instruction-dependent dynamic clock adjustment leads on average to an increase in operating speed by 38% or to a reduction in power consumption by 24%, compared to traditional synchronous clocking, which at all times has to respect the worst-case timing identified through static timing analysis.

Download Paper (PDF; Only available from the DATE venue WiFi)

18:15  4.4.4 VARIABILITY-AWARE DARK SILICON MANAGEMENT IN ON-CHIP MANY-CORE SYSTEMS
Speakers:
Muhammad Shafigue1, Dennis Gnadt1, Siddharth Garg2 and Joerg Henkel1
1Karlsruhe Institute of Technology (KIT), DE; 2University of Waterloo, CA

Abstract
Dark Silicon refers to the constraint that only a fraction of on-chip resources (cores) can be simultaneously powered-on (running at full performance) in order to stay within the allowable power budget and safe temperature limits, while others remain ‘dark’. In this paper, we demonstrate how these ‘dark cores’ can be leveraged to improve the temperature profile at run-time, thus providing opportunities to power-on more cores at the nominal voltage than the number allowed when strictly obeying the conventional Thermal Design Power (TDP) constraint. In this paper, we propose a computationally efficient dark silicon management technology that determines the best set of cores to keep dark and the mapping of threads to cores at run-time, while also accounting for the impact of process variations. We have developed a light-weight temperature prediction mechanism that determines the impact of different candidate solutions on the on-chip thermal profile. Experimental evaluation of the proposed techniques on a simulated 8×8 many-core processor, and across a range of chips to account for process variations, show that the total instruction throughput is increased by 1.8× on average while keeping the temperature within the safe limits, when compared with state-of-the-art approaches.

Download Paper (PDF; Only available from the DATE venue WiFi)

18:30 End of session
This session introduces test and validation industrial experiments. Each experiment addresses the challenges of system validation and test and shows lessons learned from industry work, interleaved with other logic development tasks. We observe that the deployed DLV tool supports this mode of work, since it is simple and intuitive. This company, using a dedicated tool developed for this purpose. A typical pattern that emerges is of designers devoting short, fragmented time periods to DLV for the initial validation of modules they develop, before these are released to systematic verification. DLV requires specific tools and methods adapted for scaling with the number of frames. Interpolation technique leads to a speed-up linked to the PSFs number reduction. Second, the caching of computationally intense processes enables speed-up (sharpness error less than 2%). The total speed-up gain with respect to the standard non-optimized model is provided by two contributors. First, the interpolation and free-space propagation techniques are used: they allow reducing the sampling space with minimal impact on the accuracy of the model consuming hence compromising the usability of the optical model in the full system virtual prototyping. To improve the model execution time, PSFs methodology is based on the usage of some point spread functions (PSFs). The use of the full set of PSFs is computationally costly and memory space improvement of design efficiency, silicon performance, and yield. The IIP design flow leads to a strong automotive requirements. Using a library of reconfigurable and robust analog IP we fast create parameterized cells up to high complexity levels including the system in the context of (1) software-only single-core solutions and (2) hardware-only multicore solutions with an ARINC 653 operating system. Effective in real case studies for specific single-core processor designs. However, some other hardware features and the advent of multicores challenge MBPTA execution time variation to drastically reduce the need for user-provided information, thus replacing uncertainty by probabilities. MBPTA relies on specific hardware and software support to randomise and/or upper bound a number of sources of worst-case execution time (WCET). MBPTA is presented in a first part of the paper, and a more detailed presentation can be obtained in the full version of the paper. In the second part, we present the first implementation of MBPTA in a real automotive case study. We show that the MBPTA model leads to a strong improvement of design efficiency, silicon performance, and yield.

### 4.5.1 SYSTEMATIC APPLICATION OF THE ISO 26262 ON A SEOOC SUPPORT BY APPLYING A SYSTEMATIC REUSE APPROACH

**Speakers:**
Alexandra Ruiz, Alberto Melzi, and Tom Kelly

**Abstract**
Automatic domain is suffering a huge transformation on the sector. The full electric vehicle is playing a role in updating the electronic systems on the car. The Electric parking system is one of those systems that are being evolving. On the other hand the entrance of the ISO 26262 functional safety standard has impacted on the automotive designs. The ISO 26262 does include The Safety Element out of Context (SEooC) on the standard. However it does not mention how to follow a systematic process in order to apply the SEooC. On this paper we present our experience on the application of the SEooC concept from the ISO 26262 to an Electric parking system. We have followed a systematic approach that takes into account the needs for a safe reuse of the elements into the whole vehicle.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 4.5.2 TIMING ANALYSIS OF AN AVIONICS CASE STUDY ON COMPLEX HARDWARE/SOFTWARE PLATFORMS

**Speakers:**
Franck Wartel, Leonidas Kosmidis, Adriana Gogonea, Zoe Stephenson, Benoit Triquet, Eduardo Quinones, Code Lo, Enrico Mezzetti, Ian Broster, Jaume Abella, Liliana Cucu, Tulio Vardenega, and Francisco Cazorla

**Abstract**
Probabilistic Timing Analysis (PTA) in general and its measurement-based variant called MBPTA in particular have been shown to facilitate the estimation of the worst-case execution time (WCET). MBPTA relies on specific hardware and software support to randomise and/or upper bound a number of sources of execution time variation to drastically reduce the need for user-provided information, thus replacing uncertainty by probabilities. MBPTA has been shown effective in real case studies for specific single-core processor designs. However, some other hardware features and the advent of multicores challenge MBPTA application in industrial-size programs. While solutions to those challenges have been proven on benchmarks, they have not been proven yet on real-world applications, whose timing analysis is far more challenging than that of simple benchmarks. This paper discusses the application of MBPTA to a real avionics system in the context of (1) software-only single-core solutions and (2) hardware-only multicore solutions with an ARINC 653 operating system.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 4.5.3 SILICON PROOF OF THE INTELLIGENT ANALOG IP DESIGN FLOW FOR FLEXIBLE AUTOMOTIVE COMPONENTS

**Speakers:**
Torsten Reich, H. D. Benjamin Prautsch, Uwe Eichler and René Buhl, Fraunhofer Institute for Integrated Circuits IIS, Design Automation Division EAS, DE

**Abstract**
In this brief paper we present the successful silicon validation of the Intelligent Analog IP (IIP) design flow applied to the design of a SMART sensor IC for automotive requirements. Using a library of reconfigurable and robust analog IP we fast create parameterized cells up to high complexity levels including the corresponding layouts. This allows us (1) to overcome time-consuming handheld analog re-design cycles, (2) to include the effects of layout parasitics into the optimization loop, and thus (3) to fast achieve different specifications even for multiple technologies. We show that the IIP design flow leads to a strong improvement of design efficiency, silicon performance, and yield.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 4.5.4 FAST OPTICAL SIMULATION FROM A REDUCED SET OF IMPULSE RESPONSES USING SYSTEMC AMS

**Speakers:**
Fabien Teysseyre, David Navarro, Ian O'Connor, Francesco Cascio, Fabio Cenni, and Olivier Guillaume

**Abstract**
In this paper we propose a methodology to simulate the optical filtering system of a camera module with limited access to proprietary data. The target of the simulation is the virtual prototyping of the overall camera module for a fine tuning of the auto-focus mechanism. For the optical system modeling, the methodology is based on the usage of some point spread functions (PSFs). The use of the full set of PSFs is computationally costly and memory space consuming hence compromising the usability of the optical model in the full system virtual prototyping. To improve the model execution time, PSFs interpolation and free-space propagation techniques are used: they allow reducing the sampling space with minimal impact on the accuracy of the model (sharpness error less than 2%). The total speed-up gain with respect to the standard non-optimized model is provided by two contributors. First, the interpolation technique leads to a speed-up linked to the PSFs number reduction. Second, the caching of computationally intensive processes enables speed-up scaling with the number of frames.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 4.5.5 DESIGNER-LEVEL VERIFICATION -- AN INDUSTRIAL EXPERIENCE STORY

**Speakers:**

**Abstract**
Designer-level verification (DLV) is now widely accepted as a necessary practice in the hardware industry. More than ever, logic designers are held responsible for the initial validation of the modules they develop, before these are released to systematic verification. DLV requires specific tools and methods adapted for designers, who are not full-time verification experts. We present user experience stories and usage statistics, describing how DLV has been practiced in our company, using a dedicated tool developed for this purpose. A typical pattern that emerges is of designers devoting short, fragmented time periods to DLV work, interleaved with other logic development tasks. We observe that the deployed DLV tool supports this mode of work, since it is simple and intuitive. This demonstrates that a suitable tool can help DLV become an integral part of a logic design project.

Download Paper (PDF; Only available from the DATE venue WiFi)
### Memory Technologies

Temperature- and power-aware solutions are proposed for self- and on-line testing, together with innovative fault detection and reconfiguration schemes for caches and emerging memory technologies.

#### VLSI Design and Architecture

**Co-Chair:** Mihalis Psarakis, University of Piraeus, GR  
**Chair:** Cristiana Bolchini, Politecnico di Milano, IT

#### Time and Location

- **Date:** Tuesday 10 March 2015  
- **Time:** 17:00 - 18:30  
- **Location:** Bayard

#### Abstracts

**MINIMUM CURRENT CONSUMPTION TRANSITION TIME OPTIMIZATION METHODOLOGY FOR LOW POWER CTS**

**Authors:** Vibhu Sharma, NXP Research, NL  
**Abstract:** The clock tree network can consume up to 40% of the power budget and is one of the limiting factors for realizing low power designs. This paper presents a novel clock transition time optimization based low power clock tree synthesis, for the non-throughput constraint designs. The proposed methodology quantifies the dependence of short circuit and switching power of the buffers on the input clock transition time, with the newly defined “weighted current strength” parameter. The reduction in the weighted current strength parameter value directly maps into the reduction in the total dynamic power of the clock tree. The proposed methodology determines the transition time constraint values for the clock signals which result in the minimum weighted current strength for the synthesized clock tree network. This technique results in up to 34% reduction in the dynamic power of the clock tree network with the existing clock tree synthesis tools and the clock tree library.

**Download Paper (PDF; Only available from the DATE venue WiFi)**

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**TEMPERATURE-AWARE SOFTWARE-BASED SELF-TESTING FOR DELAY FAULTS**

**Authors:** Ying Zhang, Zebo Peng, Jianhui Jiang, Huawe Li, and Masahiro Fujita  
**Abstract:** Delay defects under high temperature have been one of the most critical factors to affect the reliability of computer systems, and the current test methods don’t address this problem properly. In this paper, temperature-aware software-based self-testing (SBST) technique is proposed to self-heat the processors within a high temperature range and effectively test delay faults under high temperature. First, it automatically generates high-quality test programs through automatic test instruction generation (ATIG), and avoids over-testing caused by nonfunctional patterns. Second, it exploits two effective power-intensive program transformations to self-heat up the processors internally. Third, it applies a greedy algorithm to search the optimized schedule of the test templates in order to generate the test program while making sure that the temperature of the processor under test is within the specified range. Experimental results show that the generated program is successful to guarantee delay test within the given temperature range, and achieves high test performance with functional patterns.

**Download Paper (PDF; Only available from the DATE venue WiFi)**

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**A DEFECT-AWARE RECONFIGURABLE CACHE ARCHITECTURE FOR LOW-VCCTMIN DVFS-ENABLED SYSTEMS**

**Authors:** Michail Mavropoulos, Georgios Keramidas and Dimitris Nikolaos, University of Patras, GR  
**Abstract:** As process technology continues to shrink, due to manufacturing defects and process variations, a large number of bitcells in on-chip caches is expected to be faulty. The number of defective cells varies from die-to-die, wafer-to-wafer, and in the field of application depends on the run-time operating conditions (e.g., supply voltage and frequency). Those trends necessitate i) to study fault-tolerant (FT) cache mechanisms in a wide spectrum of fault-probabilities and ii) to devise appropriate FT cache techniques that must be able to adapt their fault tolerance capacity to the volume of defective locations of the target faulty caches. It is well known that keeping the cache capacity, block size and the volume of defective cells constant, the average number of misses due to faulty cells in general decreases as the associativity of the cache increases. To this end we propose DARCA, a Defect-Aware Reconfigurable Cache Architecture, which is equipped with the ability of dynamically varying its associativity according to the volume of the defective cells. To keep the hardware overhead very small, as the associativity of the cache is multiplied by a power of two, its block size is divided by the same number. Since almost all contemporary processors use prefetching, we also applied DARCA to prefetch-assisted caches. By performing cycle-accurate simulations for the SPEC2006 benchmark suite and assuming a plethora of fault maps and a wide range of fault-probabilities we showed that DARCA compares favorably against several already known FT cache mechanisms with respect to the performance loss caused by defective cells.

**Download Paper (PDF; Only available from the DATE venue WiFi)**

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**OPERATIONAL FAULT DETECTION AND MONITORING OF A MEMRISTOR-BASED LUT**

**Authors:** Nandha Kumar Thulasiraman, Haider A.F. Almurb  
**Abstract:** This paper presents a method for operational testing of a memristor-based memory look-up table (LUT). In the proposed method, the deterioration of the memristors (as storage elements of a LUT) is modeled based on the reduction of the resistance range as observed in fabricated devices and recently reported in the technical literature. A quiescent current technique is used for testing the memristors when deterioration results in a change of state, thus leading to an erroneous (faulty) operation. An equivalent circuit model of the operational deterioration for a memristor-based LUT is presented. In addition to modeling and testing, the proposed method can be utilized also for continuous monitoring of the LUT in the presence of memristor deterioration in the LUT. The proposed method is assessed using LTspice; extensive simulation results are presented with respect to different operational features, such as LUT dimension and range of resistance. These results show that the proposed test method is scalable with LUT dimension and highly efficient for testing and monitoring a LUT in the presence of deteriorating multiple memristors.

**Download Paper (PDF; Only available from the DATE venue WiFi)**
### 4.7 How Resilient Are Emerging Technologies?

**Date:** Tuesday 10 March 2015  
**Time:** 17:00 – 18:30  
**Location / Room:** Les Bons  
**Chair:** Vikas Chandra, ARM, US  
**Co-Chair:** Mehdi Tahoori, Karlsruhe Institute of Technology, DE

Many new technologies are being proposed as alternatives to conventional CMOS design. Resiliency, including robustness, reliability and fault modeling, will be a key factor in their success. This session includes results on several of these, as well as IP presentations on two others.

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<th>Time</th>
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<tr>
<td>17:00</td>
<td>4.7.1</td>
<td>DIGITAL CIRCUITS RELIABILITY WITH IN-SITU MONITORS IN 28NM FULLY DEPLETED SOI</td>
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Speakers:  
Marine Saliva, Florian Cacho, Vincent Huard, Xavier Federspiel, Damien Angot, Ahmed Benhassain, Alain Bravai and Lorena Anghel  
1STMicroelectronics, FR; 2IM2NP-ISEN, FR; 3TIMA, FR  
**Abstract**  
Aging induced degradation mechanisms occurring in digital circuits are of a greater importance in the latest technologies. Monotonous degradation such as Bias Temperature Instability (BTI) or Hot Carrier Injection (HCI) but also sudden degradation such as Dielectric Breakdown (DB) are identified as the major sources of reliability hazard. The impact of these phenomena on the digital circuits is usually observed in terms of timing degradations and thus it may result in setup/hold violation. In this paper we will focus on the impact of aging related degradation mechanisms on timing. In-situ monitor is a promising strategy to measure timing slacks and to provide pre-error warning prior timing violation. A dedicated structure has been developed to measure and benchmark the behaviors of different monitors. The technology used for the test structure and in-situ monitors are processed in 28nm Fully Depleted SOI. The workload of RCGs is observed in hardware using so called workload monitors. The output of the workload monitors is evaluated on-line to predict system degradation experienced within a configurable (short) period of time, e.g. a fraction of a second. Experimental results show that the proposed monitors predict the degradation rate with an average error of only 3% at less than 2.4% area overhead.  
Download Paper (PDF; Only available from the DATE venue WiFi) |
| 17:30 | 4.7.2 | READ/WRITE ROBUSTNESS ESTIMATION METRICS FOR SPIN TRANSFER TORQUE (STT) MRAM CELL |  
Speakers:  
Elena Ioana Vatajelu, Rosa Rodríguez-Montaño, Marco Indaco, Michel Renovell, Paolo Prinetto and Joan Figueras  
1Politecnico di Torino, IT; 2Universitat Politècnica de Catalunya, ES; 3ILRMM-CNRS, FR  
**Abstract**  
— The rapid development of low power and high density, high performance SoCs has pushed the embedded memories to their limits and opened the field to the development of emerging memory technologies. The Spin-Transfer-Torque Magnetic Random Access Memory (STT-MRAM) has emerged as a promising choice for embedded memories due to its reduced read/write latency and high CMOS integration capability. Under today aggressive technology scaling requirements, the STT-MRAM is affected by process variability making robustness evaluation an important concern. In this paper, we provide new metrics for robustness prediction of an STT-MRAM memory cell. Independent Robustness Margin metrics are defined for Read Operation and Write Operation based on the electrical characteristics of the memory cell and the fabrication induced variability. These metrics are used to estimate the extreme parameter variation causing the cell failure, Current Noise Margins and the Failure Probability of the STT-MRAM cell.  
Download Paper (PDF; Only available from the DATE venue WiFi) |
Specific examples of research directions in the cadence academic network will be given in three talks. The Cadence Academic Network was launched by Cadence in 2007. The aim was to promote the proliferation of leading-edge technologies and methodologies at universities renowned for their engineering and design excellence. A knowledge network among selected universities, research institutes, industry advisors and Cadence was established to facilitate the sharing of technology expertise in the areas of verification, design and implementation of microelectronic systems. In this paper, we deal with the above problem using inductive fault analysis on three-independent-gate silicon nanowire FETs. Simulations revealed that the current fault models, i.e. stuck-open faults, are insufficient to cover all modes of operation. The newly introduced test algorithm for stuck open can adequately capture the malfunction behavior of controllable polarity logic gates in the presence of nanowire break and bridge on polarity terminals.

**4.7 Strength by Interdisciplinary Research: The Cadence Academic Network**

**Date:** Tuesday 10 March 2015  
**Time:** 17:00 - 18:30  
**Location / Room:** Salle Lesdiguières  
**Organiser:** Patrick Haspel, Cadence Academic Network, US  
**Chair:** Jürgen Haase, edacentrum, DE

The Academic Network was launched by Cadence in 2007. The aim was to promote the proliferation of leading-edge technologies and methodologies at universities renowned for their engineering and design excellence. A knowledge network among selected universities, research institutes, industry advisors and Cadence was established to facilitate the sharing of technology expertise in the areas of verification, design and implementation of microelectronic systems.

**4.8.1** INTRODUCTION TO THE ACADEMIC NETWORK  
**Speaker:** Patrick Haspel, Cadence Academic Network, US

**4.8.2** DEPENDABILITY AND DESIGN-FOR-TESTABILITY  
**Speaker:** Said Hamdioui, Delft University of Technology, NL

**4.8.3** DIGITAL SYSTEM DESIGN  
**Speaker:** Mladen Berekovic, TU Braunschweig, DE

**4.8.4** SYSTEM LEVEL DEVELOPMENT USING VIRTUAL PROTOTYPING  
**Speakers:** Michael Hübner and Diana Goehringer, Ruhr-University Bochum, DE
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<tr>
<td>UB04.1</td>
<td>4-LOOP: 4-CORE LEON 3 WITH LINUX OPERATING SYSTEM, OPENMP LIBRARY AND HARDWARE PROFILING SYSTEM</td>
<td>Giacomo Valente, Vittoriano Muttillo and Andrea Moro, University of L'Aquila, IT</td>
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<td>Authors: Vittoriano Muttillo and Fabio Federici,</td>
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<tr>
<td>Abstract</td>
<td>Multi-processor SoC based on soft-cores are increasing the range of applications that could be implemented by exploiting FPGAs. In this context, this demo presents a symmetric multi-processor system, composed of four Leon 3 cores and a custom Linux kernel, able to execute OpenMP-based applications and enhanced with a hardware profiling system. OpenMP support and the overall profiling system are the results of R&amp;D activities conducted by several students and Professors at University of L'Aquila.</td>
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<td>UB04.2</td>
<td>THE Ψ-CHART DESIGN APPROACH IN TTOOL/DIPLODOCUS: A FRAMEWORK FOR HW/SW CO-DESIGN OF DATA-DOMINATED SYSTEMS-ON-CHIP</td>
<td>Andrea Enrici, Télécom ParisTech, FR</td>
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<td>Authors: Ludovic Aprville, Daniel Camara and Renaud Pacalet, Télécom ParisTech, FR</td>
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<tr>
<td>Abstract</td>
<td>In the scope of the DATE 2015 University Booth, we present our latest achievements for the system level design of parallel and distributed embedded systems. We propose a demonstration of a novel design approach, the Ψ-chart, in TTool/DIPLODOCUS, a UML/SysML framework for the design, validation and automatic code generation for data-dominated SoCs. The Ψ-chart is a design approach where communication patterns are designed with dedicated models, independently of a pair application-architecture, before mapping phase. It allows for a complete orthogonalization of concerns between the design of computations and communications, thus achieving faster Design Space Exploration, complete design portability as well as reduced design times and costs. The subject of our demonstration is the design of the physical layer (PHY) of the transmitter part of the Zigbee wireless standard (IEEE 802.15.4) mapped onto a MPSoC architecture with shared memory. Our demonstration will illustrate the full design of the Zigbee transmitter, from models to the automatic generation of the emulation code, via simulation and formal verification. We will validate our design by comparing the output samples produced by the emulation code, with a real implementation of the transmitter on a FPGA prototyping board.</td>
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<td>UB04.3</td>
<td>WHERE IS IT? FIND THE CODE YOU ARE INTERESTED IN!</td>
<td>Jan Maltburg, University of Bremen, DE</td>
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<td>Author: Görschwin Fey, University of Bremen / German Aerospace Center, DE</td>
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<tr>
<td>Abstract</td>
<td>The demonstration presents our tool for feature localization and debugging of RTL-designs. Feature localization helps a designer to find the code relevant for a certain feature and, thus, helps him to faster understand a design previously unknown to him. The developer can choose between three basic techniques for feature localization. In the area of debugging the tools allows fault localization, reverse debugging based on dynamic data- and control-flow of the design and dynamic slicing.</td>
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<td>UB04.4</td>
<td>HIPE-NIRGAM: A TOOL CHAIN BASED FRAMEWORK FOR MODELLING THERMAL - AWARE RELIABILITY ESTIMATION IN 2D MESH NOCS</td>
<td>Ashish Sharma, Malaviya National Institute of Technology, Jaipur, IN</td>
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<td>Authors: Manoj Singh Gauri, Lava Bhargava1, Vijay Laxmi1 and Mark Zwolinski 2</td>
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<td>1Malaviya National Institute of Technology, Jaipur, IN; 2University of Southampton, GB</td>
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<td>Abstract</td>
<td>Every three years, power density in system-on-chip (SoCs) gets doubled. As the semiconductor technology is scaling, the number of cores and interconnect network connections are increasing. To improve system performance while meeting permissible power limits, Chip-Multi Processors (CMPs) and many-core processors have emerged as an appealing solution. One of the significant aspects of many-core design is an on chip interconnect network that can effectively support intra-core and inter-core communications. This interconnect should be scalable, support high communication bandwidth and multiple concurrent connections among cores. Network-on-chip (NoC) replaces the traditional bus based interconnect architecture as former is scalable, has higher bandwidth, fault tolerance and offers parallelism. Regular NoC topologies improve scalability too. Adaptive NoC routing solutions distribute power densities and delay onset of hotspot creation. With ever-growing demand of computation and communication bandwidth by applications, the system designer need to consider and address resultant power and thermal issues in SoC as well as NoC design. Design tools need to incorporate thermal effects in design and evaluation of prototypes. Abstract--- Regional temperature differential and hotspots are two thermal problems in network-on-chip. On-chip thermal problems have an adverse impact on system performance and reliability. We propose creation of a toolchain based framework for incorporating thermal evaluation of NoC through existing simulation tools. Our proposed framework provides an integration of NoC simulator with power and thermal simulation models for analyzing the thermal hotspots and can be used for thermal-aware reliability estimation. In our framework, reliability estimation is based on life time failure models such as TDDB (Time dependent dielectric breakdown), NBTI (Negative bias temperature instability) and SM (Stress Migration). In our proposed reliable measurement is based on MTTF (Mean time to fail) comparative value. Our tool chain consists NIRGAM as a NoC simulator, NoC configuration parameters such as number of virtual channel, buffer size, routing logic, simulation cycles and application traffic are passed to power models (Orion 2.0 and McPAT). Power models provide the power trace and area of given NoC configuration. The power model results are further used in Hotspot 5.02 (HOTSPOT) thermal simulation model for generating floorplan and temperature trace (steady temperature file). The steady temperature trace used in reliability estimation tool REST [REST_tool] to estimating MTTF values. Abstract--- We believe that this generic framework can be used by researchers on academia and industry to incorporate thermal-aware reliability estimation in their design exploration.</td>
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<td>UB04.5</td>
<td>NUMERICAL METHODS FOR EFFICIENT SIMULATIONS OF CIRCUITS WITH SEPARATED TIME SCALES</td>
<td>Genie Hsieh, Sandia National Laboratories, US</td>
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<tr>
<td>Abstract</td>
<td>Circuit simulations can support to analyze and predict the performance, safety, and reliability of nuclear weapons and to certify their functionality. Small circuits with strong, nonlinear oscillations (i.e. circuits have separated fast/slow time scales; hereafter denoted by “fast/slow circuits”) can make the computation time of even a single simulation unmanageable. These types of circuits are common in weapon systems. Many numerical methods are proposed to speedup such simulations by utilizing multiple time variables to efficiently represent circuit signals with widely separated rates of variation. However, weapon circuits possess complex behaviors that are shown to be the outstanding challenges in this research field. In this work, we develop novel numerical methods for fast/slow weapon circuit simulations and deliver significant simulation speedups to facilitate efficient weapon assurance.</td>
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**UB04.7 AIDASOFT: ANALOG IC DESIGN AUTOMATION**

**Presenter:**
Nuno Horta, Instituto de Telecomunicações/Instituto Superior Técnico, PT

**Authors:**
Nuno Lourenço¹, Ricardo Martins¹, Ricardo Póvoa¹, António Canelas¹, Ricardo Lourenço² and Pedro Ventura²

¹Instituto de Telecomunicações/Instituto Superior Técnico, PT; ²Instituto de Telecomunicações, PT

**Abstract**
This demo presents AIDA an ongoing project at Instituto de Telecomunicações/University of Lisbon, Portugal, which addresses analog IC design automation from circuit-level specifications to layout descriptions in GDS-II. AIDA consists of two main modules AIDA-C and AIDA-L. AIDA-C is demonstrated for layout-aware circuit-level sizing and optimization by generating a family of robust Pareto Optimal solutions. AIDA-L is demonstrated by generating the layout taking into account electrical currents information to mitigate electromigration and IR-drop effects, and also wiring symmetry for multiport multi-terminal signal nets of analog ICs.

**More information...**

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**UB04.8 XTSI: THE 3-D ELECTRO-THERMAL SIMULATOR**

**Presenter:**
Jürgen Scheible, Reutlingen University, DE

**Author:**
Carl Christoph Jung, Reutlingen University, DE

**Abstract**
xtSi is a 3d electro-thermal simulation tool for integrated circuits. It uses a computationally efficient algorithm, which allows the simulation of typical ICs in only a few minutes. The temperature distribution is depicted graphically and with temporal resolution in a specially designed graphical user interface. With the help of xtSi designers can exactly identify isotherms and hotspots, thus enabling an optimization of the layout due to temperature effects. xtSi has been verified experimentally for device temperatures exceeding 500 °C up to the onset of thermal runaway.

**More information...**

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**UB04.9 BONDCALC: THE BOND CALCULATOR**

**Presenter:**
Carl Christoph Jung, Reutlingen University, DE

**Authors:**
Christian Silber¹ and Juergen Scheible²

¹Robert Bosch GmbH, DE; ²Reutlingen University, DE

**Abstract**
The Bond Calculator is a fast and exact tool to help designers to choose a bond wire, which does not fuse. The Bond Calculator is orders of magnitude faster than FEM and easy-to-use. The Bond Calculator helps designers to estimate the temperature at the bond connection itself, by calculating the time and space dependence of the power delivered from the bond wire to the chip. These temperature changes can affect the durability of the bond connection. The Bond Calculator uses a simplified simulation model to calculate the temperature profile in a bond wire from the induced current profile. This software tool has been validated by FEM and measurement.

**More information...**

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**19:30 End of session**

**Exhibition-Reception Exhibition Reception**

**Date:** Tuesday 10 March 2015

**Time:** 18:30 - 19:30

**Location / Room:** Several serving points inside the Exhibition Area

The Exhibition Reception will take place on Tuesday, March 10, 2015, from 18:30 - 19:30 in the exhibition area of the congress center, where free drinks for all conference delegates and exhibition visitors will be offered. All exhibitors are welcome to also provide drinks and snacks for the attendees.

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**5.1 SPECIAL DAY Hot Topic: Applications of IoT**

**Date:** Wednesday 11 March 2015

**Time:** 08:30 - 10:00

**Location / Room:** Salle Oisans

**Organisers:**
Rolf Drechsler, University of Bremen/DFKI GmbH, DE
Ahmed Jerraya, CEA-Leti, FR

**Chair:**
Gabriela Nicolescu, Ecole Polytechnique Montreal, CA

**Co-Chair:**
Ahmed Jerraya, CEA-Leti, FR

Internet of things (IoT) applications is changing the landscape of the whole society and even non-traditional ICT intensive domains. More products in all market segments are emerging every day and is changing the way human and machines are interacting. This represents a great opportunity for innovators in industry and new vistas of research for academia. This session overview several application domains already impacted by this IoT wave.

**Time** | **Label** | **Presentation Title** | **Authors**
--- | --- | --- | ---
08:30 | 5.1.1 | IOT FOR HEALTHCARE | Giovanni De Micheli, École Polytechnique Fédérale de Lausanne (EPFL), CH
08:52 | 5.1.2 | IOT FOR SMART HOME | Sylvain Paineau, Schneider Electric, FR
09:14 | 5.1.3 | IOT FOR AUTOMOTIVE | Juergen Hornung, Robert Bosch GmbH, DE
09:36 | 5.1.4 | IOT FOR SMART CITIES | Levent Gurgen, CEA/LETI, FR
This session proposes novel techniques to detect hardware Trojans inserted at gate level and presents improvements and novel targets for fault attacks.

**5.2 Hardware Trojan and Active Implementation Attacks**

**Date:** Wednesday 11 March 2015  
**Time:** 08:30 - 10:00  
**Location / Room:** Belle Etoile

**Chair:**  
Paolo Maistri, TIMA, FR

**Co-Chair:**  
Viktor Fischer, Hubert Curien Laboratory, FR

This session proposes novel techniques to detect hardware Trojans inserted at gate level and presents improvements and novel targets for fault attacks.

**5.2.1 IMPROVED PRACTICAL DIFFERENTIAL FAULT ANALYSIS OF GRAIN-128**

**Speakers:**  
Prakash Dey¹, Abhishek Chakraborty², Avishek Adhikari¹ and Debdeep Mukhopadhyay²  
¹Department of Pure Mathematics, University of Calcutta, Kolkata-700019, IN; ²Department of Computer Science and Engineering, Indian Institute of Technology Kharagpur, Kharagpur-721302, IN

**Abstract**

Differential Fault Attacks (DFA) on stream ciphers have been an active field of research. However, their practical realizations have not been reported in the public literature. Hence, the assumptions on the fault models made in the context of DFA for stream ciphers have not been studied. Furthermore, there have been few efforts reported on the popular stream cipher candidate, Grain-128. We consider a simple low-cost fault injection set-up, using clock glitches and show that in stream ciphers the critical path of the circuit affects few bit positions (the feedback bit for the Shift Registers in the stream ciphers). Thus the fault is often localized to single bit position, and because of the absence of required faulty ciphers makes existing theoretical DFAs invalid. In order to create multiple instances of contiguously located faults, we use clock glitches to induce the fault, and then use the shifting property of the internal registers of Grain to create multiple instances of contiguously located faults. In parallel, we also develop a more relaxed DFA for Grain-128, to show that when the fault is k neighbourhood bits, $k \in \{1, \ldots, 5\}$, the attack is successful to retrieve the key without knowing the locations or exact number of bits flipped by the internal fault. We also devise a technique for rejecting the bad faults with high probabilities, i.e., when the faults are not in the contiguous location as required in the attack. Combining the above attacks we demonstrate using a simple set-up via clock glitches that such faults can be practically obtained and analysed using the proposed attack algorithm to retrieve the key.

Download Paper (PDF; Only available from the DATE venue WiFi)

**5.2.2 A SCORE-BASED CLASSIFICATION METHOD FOR IDENTIFYING HARDWARE-TROJANS AT GATE-LEVEL NETLISTS**

**Speakers:**  
Masaru Oya, Youhua Shi, Masao Yanagisawa and Nozomu Togawa, Waseda University, JP

**Abstract**

Recently, digital ICs are often designed by outside vendors to reduce design costs in semiconductor industry, which may introduce severe risks that malicious attackers implement Hardware Trojans (HTs) on them. Since IC design phase generates only a single design result, an RT-level or gate-level netlist for example, we cannot assume an HT-free netlist or a Golden netlist and then it is too difficult to identify whether a generated netlist is HT-free or HT-inserted. In this paper, we propose a score-based classification method for identifying HT-free or HT-inserted gate-level netlists without using a Golden netlist. Our proposed method does not directly detect HTs themselves in a gate-level netlist but a net included in HTs, which is called Trojan net, instead. Firstly, we observe Trojan nets from several HT-inserted benchmarks and extract several their features. Secondly, we give it scores to extracted Trojan net features and sum up them for each net in benchmarks. Then we can find out a it score threshold to classify HT-free and HT-inserted netlists. Based on these scores, we can successfully classify HT-free and HT-inserted netlists in all the Trust-HUB gate-level benchmarks. Experimental results demonstrate that our method successfully identify all the HT-inserted gate-level benchmarks to be HT-inserted and all the HT-free gate-level benchmarks to be HT-free in approximately three hours for each benchmark.

Download Paper (PDF; Only available from the DATE venue WiFi)
HARDWARE TROJAN DETECTION FOR GATE-LEVEL ICS USING SIGNAL CORRELATION BASED CLUSTERING

Speakers: Burcin Cakir and Sharad Malik, Princeton University, US

Abstract
Malicious tampering of the internal circuits of ICs can lead to detrimental results. Insertion of Trojan circuits may change system behavior, cause chip failure or send information to a third party. Trojans are hidden cleverly by the adversary to evade detection using typical pre-silicon verification and post-manufacturing testing. Therefore, the validation of chips to detect these has emerged as an important problem, particularly for safety-critical applications. This paper presents an information-theoretic approach for Trojan detection. It estimates the statistical correlation between the signals in a design, and explores how this estimation can be used in a clustering algorithm to detect the Trojan logic. The gate level circuit is modeled as a weighted graph. The edge weights are determined using correlations between the signal transitions at the inputs and outputs of a gate based on simulation data. These weights are used to compute a distance metric in a density-based clustering algorithm. This approach exploits the fact that Trojans have a stealthy nature. The nodes which are nearly unused and hence, have weak correlation with the rest of the circuit, are detected as outliers by this clustering method and flagged as suspicious. Compared with the other algorithms, our tool does not require extensive logic analysis. We neither need the circuit to be brought to the triggering state, nor the effect of the Trojan payload to be propagated and observed at the output. Instead we leverage already available simulation data in this information-theoretic approach. We conducted experiments on the TrustHub benchmarks to validate the practical efficacy of this approach. The results show that our tool can detect Trojan logic with up to 100% coverage with low false positive rates.

Download Paper (PDF; Only available from the DATE venue WiFi)

5.3 Variability Challenges in Nanoscale Circuits

Date: Wednesday 11 March 2015
Time: 08:30 - 10:00
Location / Room: Stendhal

Chair: Pablo Garcia del Valle, École Polytechnique Fédérale de Lausanne (EPFL), CH
Co-Chair: Muhammad Shafique, Karlsruhe Institute of Technology, DE

This session proposes new techniques to address variability related challenges in nanoscale chips. The topics addressed include retention time variations in DRAM and variations in the power delivery network.
5.3.1 EXPLOITING DRAM RESTORE TIME VARIATIONS IN DEEP SUB-MICRON SCALING

Speakers:
Xianwei Zhang¹, Youtao Zhang¹, Bruce Childers² and Jun Yang²

¹Department of Computer Science, University of Pittsburgh, US; ²Electrical and Computer Engineering Department, University of Pittsburgh, US

Abstract
Recent studies reveal that one of the major challenges in scaling DRAM in deep-sub-micron regime is its significant variations on cell restore time, which are caused by conventional circuit optimization techniques (e.g., gate sizing). With a given circuit netlist, we study the bound of the potential benefits provided by variation effects in nanometer circuits. In this paper, we propose schemes to expose the variations to the architectural level. By constructing memory chunks with different accessing speeds and, in particular, exploiting the performance benefits of fast chunks, a variation-aware memory controller can effectively compensate the performance loss due to relaxed timing constraints. Our experimental results show that, comparing to traditional designs such as row sparing and ECC, the proposed schemes help to improve system performance by up to 10.3% and 12.9%, respectively, for 20nm and 14nm tech nodes on a 4-core multiprocessor system.

Download Paper (PDF; Only available from the DATE venue WiFi)

5.3.2 ADAPTIVELY TOLERATE POWER-GATING-INDUCED POWER/GROUND NOISE UNDER PROCESS VARIATIONS

Speakers:
Zhe Wang, Xuan Wang, Jiang Xu, Xiaowen Wu, Zhehu Wang, Peng Yang, Luan H. K. Duong, Haoran Li, Rafael K. V. Maeda and Zhifei Wang, HKUST, HK

Abstract
Power gating is one of the most effective techniques to reduce the leakage power in multiprocessor system-on-chips (MPSoCs). However, the power-mode transition during the power gating period of an individual processing unit will introduce serious power/ground (P/G) noise to the neighboring processing units. As technology scales, the P/G noise problem becomes a severe reliability threat to MPSoCs. At the same time, the increasing manufacturing process variations also bring uncertainties to the P/G noise problem and make it difficult to predict and deal with. In order to address this problem, for the first time, this paper analyzes the power-gating-induced P/G noise in the presence of process variations, and proposes a hardware-software collaborated online method to adaptively process computing units from P/G noise. Sensor network-on-chip (SENoC) is used to gather noise information and coordinate different system components. Meanwhile an online software-based algorithm is developed to effectively decide the noise impact range and arrange protections for affected processing units based on the collected information. We evaluate the proposed method through Monte Carlo simulations on a NoC-based MPSoC platform. The experimental results show that for a set of real applications, our method achieves on average 13.2% overall performance improvement and 13.3% system energy reduction compared with the traditional stop-go method.

Download Paper (PDF; Only available from the DATE venue WiFi)

5.3.3 ENERGY VERSUS DATA INTEGRITY TRADE-OFFS IN EMBEDDED HIGH-DENSITY LOGIC COMPATIBLE DYNAMIC MEMORIES

Speakers:
Adam Teman¹, Georgios Karakonstantis², Robert Giterman³, Pascal Meinerzhagen⁴ and Andreas Burg¹

¹École Polytechnique Fédérale de Lausanne (EPFL), CH; ²Queen's University, CH; ³Ben-Gurion University, IL; ⁴Intel Labs, US

Abstract
Current variation aware design methodologies, tuned for worst-case scenarios, are becoming increasingly pessimistic from the perspective of power and performance. A good example of such pessimism is setting the refresh rate of DRAMs according to the worst-case access statistics, thereby resulting in very frequent refresh cycles, which are responsible for the majority of the standby power consumption of these memories. However, such a high refresh rate may not be refreshed, either due to extremely low probability of the actual occurrence of such a worst-case, or due to the inherent error resilient nature of many applications that can tolerate a certain number of potential failures. In this paper, we exploit and quantify the possibilities that exist in dynamic memory design by shifting to the so-called approximate computing paradigm in order to save power and enhance yield at no cost. The statistical characteristics of the retention time in dynamic memories were revealed by studying a fabricated 24b CMOS compatible embedded DRAM (eDRAM) memory array based on gain-cells. Measurements show that up to 73% of the retention power can be saved by altering the refresh time and setting it such that a small number of failures is allowed. We show that these savings can be further increased by utilizing known circuit techniques, such as body biasing, which can help, not only in extending, but also in preferably shaping the retention time distribution. Our approach is one of the first attempts to access the data integrity and energy trade-offs achieved in eDRAMs for utilizing them in error resilient applications and can prove helpful in the anticipated shift to approximate computing.

Download Paper (PDF; Only available from the DATE venue WiFi)

5.3.4 RETENTION TIME MEASUREMENTS AND MODELLING OF BIT ERROR RATES OF WIDE-I/O DRAM IN MPSoCS

Speakers:
Christian Weis¹, Matthias Jung², Peter Elsès¹, Cristiano Santos², Pascal Vivet³, Sven Goossens ⁴, Martijn Koedam ⁴ and Norbert Wehn¹

¹University of Kaiserslautern, DE; ²UFGRS, Porto Alegre and CEA-Leti, France, BR; ³CEA-Leti, FR; ⁴Eindhoven University of Technology, NL

Abstract
DRAM cells use capacitors as volatile and leaky bit storage elements. The time spent without refreshing them is called retention time. It is well known that the retention time depends inversely exponentially on the temperature. In 3D stacking, the challenges of high power densities and thermal dissipation are exacerbated and have a much stronger impact on the retention time of 3D-stacked WIDE-I/O DRAMs that are placed on top of an MPSoC. Consequently, it is very important to study the temperature behaviour of WIDE-I/O DRAMs. To the best of our knowledge, no investigations based on real measurements were done for stacked DRAM-on-logic devices. In this paper, we first provide detailed measurements on temperature-dependent retention time and bit error rates of WIDE-I/O DRAMs. To obtain the correct temperature distribution of the WIDE-I/O DRAM die we use an advanced thermal modelling tool: the DOECA AcetabThermalModeler™ (ATM). The WIDE-I/O DRAM retention times and bit error rates are compared to the behaviour of 2D-DRAM chips (DIMMs) with the help of an advanced FPGA-based test system. We observed data pattern dependencies and variable retention times (VRTs). Second, based on this data, we develop and validate a SystemC-TLM2.0 DRAM bit error rate model. Our proposed DRAM bit error model enables early investigations on the temperature vs. retention time trade-off in future 3D-stacked MPSoCs with WIDE-I/O DRAMs in SystemC-TLM2.0 environments.

Download Paper (PDF; Only available from the DATE venue WiFi)

10:00 5.4 ON THE PREMISES AND PROSPECTS OF TIMING SPECULATION

Speakers:
Rong Ye¹, Feng Yuan², Jie Zhang² and Qiang Xu²

¹Imperial College, GB; ²The Chinese University of Hong Kong, HK

Abstract
Timing speculation (TS), being able to detect and correct circuit timing errors at runtime, is a promising alternative solution to mitigate the ever-increasing variation effects in nanometer circuits. The potential energy-efficiency improvement, however, is limited by the circuit “timing wall”, a critical operating point caused by conventional circuit optimization techniques (e.g., gate sizing). With a given circuit netlist, we study the bound of the potential benefits promised by TS techniques in this work, which facilitate designers to decide whether it is worth the effort to implement a timing-speculative circuit. Experimental results on benchmark circuits demonstrate the effectiveness of the proposed methodology.

Download Paper (PDF; Only available from the DATE venue WiFi)
The introduction of Multiple Patterning (MP) in sub-32nm technology nodes may pose severe variability problems in wire resistance and capacitance of IC circuits. In this paper we evaluate the impact of this variability on the performance of SRAM cell arrays based on the 10nm technology node, for a relevant range of process variation assumptions. The MP options we consider are the triple Litho-Etch (LE3) and the Self Aligned Double Patterning (SADP), together with Single Patterning Extreme-UV (EUV). In addition to the analysis of the worst-case variability scenario and the impact on SRAM performance, we propose an analytical formula for the estimation of SRAM read time penalty, using the RC variation of the bit line and the array size as input parameters. This formula, verified with SPICE simulations, allows a fast extraction of the statistical distribution of the read time penalty, using the Monte-Carlo method. Results on each patterning option are presented and compared.

Download Paper (PDF; Only available from the DATE venue WiFi)
09:00 5.4.2 ENABLING VERTICAL WORMHOLE SWITCHING IN 3D NOC-BUS HYBRID SYSTEMS
Speakers:
Changjin Chen, Marius Enachescu and Sorin Cotofana, Delft University of Technology, NL
Abstract
In Networks-on-Chip (NoC) systems Wormhole Switching (WS) enables lower packet transmission latency and requires less silicon real estate than the
Packet Switching (PS). However, enabling vertical WS in conventional 3D NoC-Bus hybrid systems requires a large amount of TSVs, which have low yield in
state of the art 3D staking technology. In this paper, we alleviate this issue by introducing a Bus Virtual Channel (VC) Allocation (BVA) mechanism, which
assigns to at most one cross layer packet a free input VC in its target router before injecting it into the bus. In this way, a routing path is reserved by the
head flit, and the rest of the packet flits can be BS transmitted through the vertical buses. Given that VC allocation is performed only once per packet per
hop BVA can be performed in such a way that it doesn’t become a system bottleneck. We evaluated our proposal with both synthetic and real application
traffic and the experimental results indicate that when vertical WS is implemented, the bus critical path length is reduced by at least 31% and the average
packet transmission latency is reduced by at least 22%, when compared with conventional pipelined bus or TDMA bus based systems. Moreover, the area
cost and power consumption of the output buffer incident to the bus are reduced by 47% and 43%, respectively.
Download Paper (PDF; Only available from the DATE venue WiFi)

09:30 5.4.3 A CLOSED LOOP TRANSMITTING POWER SELF-CALIBRATION SCHEME FOR ENERGY EFFICIENT WINOC ARCHITECTURES
Speakers:
Maurizio Palesi, Kore University, IT
Authors:
Andrea Mineo1, Mohd Shahrizal Rusli2, Maurizio Palesi3, Giuseppe Ascia1, Vincenzo Catania1 and M. N. Marsono2
1University of Catania, IT; 2Universiti Teknologi Malaysia, MY; 3Kore University, IT
Abstract
In a wireless Network-on-Chip (WiNoC) the radio transceiver accounts for a significant fraction of the total communication energy. Recently, a configurable
transceiver architecture able to regulate its transmitting power based on the location of the destination node has been proposed. Unfortunately, the use of
such transceiver requires a costly, time consuming and complex characterization phase performed at design time and mainly based on the use of field solver
simulators whose accuracy has not yet been proved in the context of integrated on-chip antennas. In this paper we present a closed loop transmitting power
self-calibration mechanism which allows to determine on-line the optimal transmitting power for each transmitting and receiving pair in a WiNoC. The
proposed mechanism is general and can be applied to any WiNoC architecture with a low overhead in terms of silicon area. Its application to three well
known WiNoC architectures shows its effectiveness in drastically reducing the overall communication energy (up to 50%) with a limited impact on
performance.
Download Paper (PDF; Only available from the DATE venue WiFi)

10:00 5.5.4 COHERENCE BASED MESSAGE PREDICTION FOR OPTICALLY INTERCONNECTED CHIP MULTIPROCESSORS
Speakers:
Anouk Van Laer1, Chamath Ellawala1, Muhammad Ridwan Madarbus1, Timothy M. Jones2 and Philip M. Watts1
1University College London, GB; 2University of Cambridge, GB
Abstract
Photonic networks on chip have been proposed to reduce latency and power consumption of on-chip communication in chip multiprocessors. However, in
switched photonic networks, the path setup latency can create a high overhead, particularly for the short messages generated by shared memory chip
multiprocessors (CMP). This has led to proposals for networks which avoid switching using all-to-all or single writermultiple reader (SWMR) networks which
dramatically increase optical component counts and hence power consumption. In this work we propose a predictor which uses information from the
coherence protocol and previously transmitted messages to predict future messages and hence hide the path setup latency by speculatively setup photonic
paths. We show that a directly mapped predictor can achieve prediction hit rates of up to 85% for PARSEC benchmarks in a 16-core x86 system using the
MESI coherence protocol whereas a more resource efficient set associative predictor can still achieve prediction rates up to 75%
Download Paper (PDF; Only available from the DATE venue WiFi)

10:00 End of session
Coffee Break in Exhibition Area
Coffee Break in Exhibition Area
On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area.

Lunch Break
On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a
voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Ecrins (for fully registered conference delegates only).

Tuesday, March 10, 2015
Coffee Break 10:30 - 11:30
Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
Coffee Break 16:00 - 17:00

Wednesday, March 11, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)
Coffee Break 16:00 - 17:00

Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

5.5 Critical Embedded Systems
Date: Wednesday 11 March 2015
Time: 08:30 - 10:00
Location / Room: Meije
Chair:
Lothar Thiele, Swiss Federal Institute of Technology Zurich, CH
Co-Chair:
The papers in this session focus on design concerns for safety-critical embedded systems. Topics include scheduling for engine-control tasks, fault tolerance, real-time communication, and safety and security in embedded systems.

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<td>5.5.2</td>
<td>ENGINE CONTROL: TASK MODELLING AND ANALYSIS</td>
<td>Alessandro Biondi and Giorgio Buttazzo, Scuola Superiore Sant’Anna, IT</td>
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<td>09:30</td>
<td>5.5.3</td>
<td>EVALUATION OF DIVERSE COMPILING FOR SOFTWARE-FAULT TOLERANCE</td>
<td>Andrea Höller1, Nermin Kajtazovic1, Tobias Rauter2, Kay Römer2 and Christian Kreiner2</td>
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<td>10:00</td>
<td>IP2-9</td>
<td>OPENMP AND TIMING PREDICTABILITY: A POSSIBLE UNION?</td>
<td>Roberto Vargas1, Eduardo Quiones2 and Andrea Marongiu3</td>
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**ENGINE CONTROL: TASK MODELLING AND ANALYSIS**

**Abstract**

Engine control is characterized by computational activities that are triggered by specific crankshaft rotation angles and are designed to adapt their functionality based on the angular velocity of the engine. Although a few models have been proposed in the literature to handle such tasks, most of them are quite simplistic and do not allow expressing features that are presently used by the automotive industry. This paper proposes a new task model for expressing realistic features of engine control tasks and presents a real-time analysis for applications consisting of multiple engine control tasks and classical periodic tasks.

Download Paper (PDF; Only available from the DATE venue WiFi)

**EVALUATION OF DIVERSE COMPILING FOR SOFTWARE-FAULT TOLERANCE**

**Abstract**

Although software fault prevention techniques improve continually, faults remain in every complex software system. Thus safety-critical embedded systems need mechanisms to tolerate software faults. Typically, these systems use static redundancy to detect hardware faults during operation. However, the reliability of a redundant system not only depends on the reliability of each version, but also on the dissimilarity between them. Thus, researchers have investigated ways to automatically add cost-efficient diversity to software to increase the efficiency of redundancy strategies. One of these automated software diversification methods is diverse compiling, which exploits the diversity introduced by different compilers and different optimization flags. Today, diverse compiling is used to improve the hardware fault tolerance and to avoid common defects from compilers. However, in this paper we show that diverse compiling also enhances the software fault tolerance by increasing the chance of finding defects in the source code of the executed software during runtime. More precisely, the memory is organized differently, when using different compilers and compiler flags. This enhances the chance of detecting memory-related software bugs, such as missing memory initialization, during runtime. Here we experimentally quantify the efficiency of diverse compiling for software fault tolerance and we show that diverse compiling can help to detect up to about 70% of memory-related software bugs.

Download Paper (PDF; Only available from the DATE venue WiFi)

**OPENMP AND TIMING PREDICTABILITY: A POSSIBLE UNION?**

**Abstract**

Next-generation many-core embedded platforms have the chance of intercepting a converging need for high performance and predictability. Programming methodologies for such platforms will have to promote predictability as a first-class design constraint, along with features for massive parallelism exploitation. OpenMP, increasingly adopted in the embedded systems domain, has recently evolved to deal with the programmability of heterogeneous many-cores, with mature support for fine-grained task parallelism. While tasking is potentially very convenient for coding real-time applications modeled as periodic task graphs, OpenMP adopts an execution model completely agnostic to any timing requirement that the target application may have. In this position paper we reason about the suitability of the current OpenMP v4 specification and execution model to provide timing guarantees in many-cores.

Download Paper (PDF; Only available from the DATE venue WiFi)
SAHARA: A SECURITY-AWARE HAZARD AND RISK ANALYSIS METHOD

Speakers:
Georg Macher¹, Harald Sporer¹, Reinhard Berlach¹, Eric Armengaud² and Christian Kreiner¹
¹Graz University of Technology, AT; ²AVL List GmbH, AT

Abstract
Safety and Security appear to be two contradicting overall system features, which challenge researchers for decades. Traditionally, these two features have been treated separately, but due to increasing awareness of mutual impacts, cross domain knowledge and fine grasp of commonalities becomes more important. Due to increasing interlacing of systems (such as Car2x in the automotive domain) it is no longer acceptable to assume safety systems immune from security risks and vice versa. Future automotive systems require appropriate systematic approaches to support safety aware security development. Therefore, this paper presents a combined approach of the automotive HARA (hazard analysis and risk assessment) with the security domain STRIDE approach to trace impacts of security issues on safety concepts on system level. We present an approach to classify the probability of security threats to determine the appropriate amount of countermeasures to be considered. Furthermore, we analyze the impact of these security threats on safety analysis of automotive systems. The paper describes how such a method has been developed based on the HARA approach and how a safety-critical contribution of successful security attacks can be quantified and proceeded.

Download Paper (PDF; Only available from the DATE venue WiFi)

10:00
End of session
Coffee Break in Exhibition Area
Coffee Break in Exhibition Area
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Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00; Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

5.6 Analyzing and Improving Memories

Date: Wednesday 11 March 2015
Time: 08:30 - 10:00
Location / Room: Bayard
Chair: Robert Aitken, ARM, US
Co-Chair: Panagiota Papavramidou, IMAG, FR

Memories are a driving force behind virtually all IC designs. This session describes methods of improving memory architecture, robustness, and lifetime.

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<tr>
<td>08:30</td>
<td>5.6.1</td>
<td>ON THE STATISTICAL MEMORY ARCHITECTURE EXPLORATION AND OPTIMIZATION</td>
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</table>

Speakers:
Charalampos Antoniadis¹, Georgios Karakonstantis², Nestoras Evmorfopoulos¹, Andreas Burg³ and George Stamoulis¹
¹University of Thessaly, GR; ²Queen’s University, GB; ³École Polytechnique Fédérale de Lausanne (EPFL), CH

Abstract
The worsening of process variations and the consequent increased spreads in circuit performance and consumed power hinder the satisfaction of the targeted budgets and lead to yield loss. Corner based design and adoption of design guardbands might limit the yield loss. However, in many cases such methods may not be able to capture the real effects which might be way better than the predicted ones leading to increasingly pessimistic designs. The situation is even more severe in memories which consist of substantially different individual building blocks, further complicating the accurate analysis of the impact of variations at the architecture level leaving many potential issues uncovered and opportunities unexploited. In this paper, we develop a framework for capturing non-trivial statistical interactions among all the components of a memory/cache. The developed tool is able to find the optimum memory/cache configuration under various constraints allowing the designers to make the right choices early in the design cycle and consequently improve performance, energy, and especially yield. Our results indicate that the consideration of the architectural interactions between the memory components allow to relax the pessimistic access times that are predicted by existing techniques.

Download Paper (PDF; Only available from the DATE venue WiFi)
5.6.2 ECRIPSE: AN EFFICIENT METHOD FOR CALCULATING RTN-INDUCED FAILURE PROBABILITY OF AN SRAM CELL

Speakers:
Hiromitsu Awano, Masayuki Hiromoto and Takashi Sato, Kyoto University, JP

Abstract
Failure rate degradation of an SRAM cell due to random telegraph noise (RTN) is calculated for the first time. ECRIPSE, an efficient method for calculating the RTN-induced failure probability of an SRAM cell, has been developed to exhaustively cover a large number of possible bias-voltage combinations on which RTN statistics strongly depend. In order to shorten computational time, the Monte Carlo calculation of a single gate-bias condition is accelerated by incorporating two techniques: 1) construction of an optimal importance sampling using particles that move about the “important” regions in a variability space, and 2) a classifier that quickly judges whether the random samples are in failure regions or not. We show that the proposed method achieves at least 15.6x speed-up over the state-of-the-art method. We then integrate an RTN model to modulate failure probability. In our experiment, RTN worsens failure probability by six times than that calculated without the effect of RTN.

Download Paper (PDF; Only available from the DATE venue WiFi)

5.6.3 SUBPAGE PROGRAMMING FOR EXTENDING THE LIFETIME OF NAND FLASH MEMORY

Speakers:
Jung-Hoon Kim¹, Sang-Hoon Kim² and Jin-Soo Kim³
¹Samsung Electronics Corp., KR; ²KAIST, KR; ³Sungkyunkwan University, KR

Abstract
During the past decade, the density of NAND flash memory has been increased in many folds. The increase has been driven by storing multiple bits in a cell and scaling down the fabrication process. Such advance in manufacturing technology, however, has been significantly impaired the reliability of the flash memory so that the reliability becomes one of the major concerns in use of the flash memory. Moreover, as the flash memory writes data in the unit of flash page, the trend of the increase in page size worsens the reliability by amplifying a small update to a full flash page programming. In this paper, we propose a new programming method to improve the flash endurance cycle, especially when a small amount of data are written repeatedly. Proposed method so called "subpage programming" partitions a page into smaller subpages. A small amount of data can be programmed to one of the subpages while the other subpages are inhibited from the programming by leveraging the mechanisms of flash cell programming. Thus, the number of flash cells that undergo programming is minimized. We evaluated the effect of the proposed subpage programming on real NAND flash memory chips from three different manufacturers. Our evaluation results show that the subpage programming improves the flash endurance cycle by up to 258%.

Download Paper (PDF; Only available from the DATE venue WiFi)

5.7 Architectures and Design for Cyber-Physical Systems

Date: Wednesday 11 March 2015
Time: 08:30 - 10:00
Location / Room: Les Bans

Chair:
Rolf Ernst, Technische Universität Braunschweig, DE

Co-Chair:
Paul Pop, Technical University of Denmark, DK

The session covers architectures for non-volatile processors, mixed-criticality, reliable and self-aware systems, and design optimisation issues such as system synthesis for reliability and cost, online scheduling and FPGA acceleration.
Abstract

We address the problem of synthesizing safety-critical cyber-physical system architectures to minimize a cost function while guaranteeing the desired reliability. We cast the problem as an integer linear program on a reconfigurable graph which models the architecture. Since generating symbolic-probability constraints by exhaustive enumeration of failure cases on all possible graph configurations takes exponential time, we propose two algorithms to decrease the problem complexity, i.e. Integer-Linear Programming Modulo Reliability (ILP-MR) and Integer-Linear Programming with Approximate Reliability (ILP-AR). We compare the two approaches and demonstrate their effectiveness on the design of aircraft electric power system architectures.

Download Paper (PDF; Only available from the DATE venue WiFi)
**OCCUPANCY DETECTION VIA IBEACON ON ANDROID DEVICES FOR SMART BUILDING MANAGEMENT**

**Speakers:** Andrea Corna, Lorenzo Fontana, Alessandro Antonio Nacci and Donatella Sciuto, Politecnico di Milano, IT

**Abstract**

Building heating, ventilation, and air conditioning (HVAC) systems are considered to be the main target for energy reduction due to their significant contribution to commercial buildings’ energy consumption. Knowing a building’s occupancy plays a crucial role in implementing demand-response HVAC. In this paper we propose a new solution based on the iBeacon technology. This solution is different from the previous ones because it leverages on the Bluetooth Low Energy standard, which provides lower power consumption. Moreover, the iBeacon protocol can be used both on iOS systems and Android ones, making this new approach portable. Differently from our previous work based on iOS devices, in this paper we focus on an Android based solution with the aim of increasing the accuracy of the location and the energy efficiency of the entire system. We increased the accuracy by 10% and the energy efficiency by 15%.

Download Paper (PDF; Only available from the DATE venue WiFi)

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**A NEURAL MACHINE INTERFACE ARCHITECTURE FOR REAL-TIME ARTIFICIAL LOWER LIMB CONTROL**

**Speakers:** Jason Kane, Qing Yang, Robert Hernandez, Willard Simoneau and Matthew Seaton, University of Rhode Island, US

**Abstract**

This paper presents a novel architecture of a lower limb neural machine interface (NMI) for determination of user intent. Our new design and implementation paves the way for future bionic legs that require high speed real-time deterministic response, high accuracy, easy portability, and low power consumption. A working FPGA-based prototype has been built, and experiments have shown that it achieves average performance gains of around 8x that of the equivalent software algorithm running on an Intel Core i7 2670QM, or 24x that of an Intel Atom Z530 with no perceivable loss in accuracy. Furthermore, our fully pipelined and parallel non-linear support vector machine-based FPGA implementation led to a 6.4x speedup over an equivalent GPU-based design. In this paper, we also characterize our achieved timing margin to show that our design is capable of supporting real-time wireless communications. With additional refinement, such a wireless personal area network (PAN) system will provide improved flexibility on an individual basis for electromyography (EMG) sensor placement.

Download Paper (PDF; Only available from the DATE venue WiFi)

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**5.8 Hot Topic - The Next Generation of Virtual Prototyping: Ultra-fast yet Accurate Simulation of HW/SW Systems**

**Date:** Wednesday 11 March 2015
**Time:** 08:30 - 10:00
**Location / Room:** Salle Lesdiguières

**Organisers:**
Daniel Müller-Gritschneder, Technische Universität München, DE
Oliver Bringmann, University of Tübingen, DE

**Chair:**
Andy D. Pimentel, University of Amsterdam, NL

This session addresses leading-edge solutions in the field of virtual prototyping. Employing techniques such as source-level software simulation, host-compiled firmware, OS and processor modeling, as well as abstract communication and peripheral models, it is possible to reach very high simulation speeds. With intelligent new out-of-order modeling, synchronization and temporal decoupling techniques, such ultra-fast simulation can be achieved while also maintaining a very high accuracy.

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**ULTRA-FAST SOURCE-LEVEL TIMING SIMULATION - HIGH ACCURACY NEEDS EXACT CODE MATCHING**

**Speaker:**
Oliver Bringmann, University of Tuebingen / FZI, DE

**HOST-COMPiled OPERATING SYSTEM AND PROCESSOR MODELING**

**Speaker:** Andreas Gerstauer, The University of Texas at Austin, US
ON-LINE PREDICTION OF NBTI-INDUCED AGING RATES

Speakers:
Rafal Baranowski, Farshad Firouzi, Saman Kiamehr, Chang Liu, Hans-Joachim Wunderlich and Mehdi Tahoori

Abstract
Nanoscale technologies are increasingly susceptible to aging processes such as Negative-Bias Temperature Instability (NBTI) which undermines the reliability of VLSI systems. Existing monitoring techniques can detect the violation of safety margins and hence make the prediction of an imminent failure possible. However, since such techniques can only detect measurable degradation effects which appear after a relatively long period of system operation, they are not well suited to early aging prediction and proactive aging alleviation. This work presents a novel method for the monitoring of NBTI-induced degradation rate in digital circuits. It enables the timely adoption of proper mitigation techniques that reduce the impact of aging. The proposed method employs machine learning techniques to find a small set of so called Representative Critical Gates (RCG), the workload of which is correlated with the degradation of the entire circuit. The workload of RCGs is observed in hardware using so called workload monitors. The output of the workload monitors is evaluated on-line to predict system degradation experienced within a configurable (short) period of time, e.g. a fraction of a second. Experimental results show that the proposed monitors predict the degradation rate with an average error of only 3% at less than 2.4% area overhead.

Download Paper (PDF; Only available from the DATE venue WiFi)
IP2-3 RETRAINING BASED TIMING ERROR MITIGATION FOR HARDWARE NEURAL NETWORKS

Speakers: Jiachao Deng1, Yuntan Fang1, Zidong Du1, Ying Wang1, Huawei Li1, Olivier Temam2, Paolo Jenni2, David Novo3, Xiaowe Li1, Yunji Chen1 and Chengyong Wu1
1State Key Laboratory of Computer Architecture, ICT, CAS, Beijing, China; 2University of Chinese Academy of Sciences, Beijing, China, CN; 3INRIA Saclay, France, FR;
2École Polytechnique Fédérale de Lausanne (EPFL), CH

Abstract
Recently, neural network (NN) accelerators are gaining popularity as part of future heterogeneous multi-core architectures due to their broad application scope and excellent energy efficiency. Additionally, since neural networks can be retrained, they are inherently resilient to errors and noises. Prior work has utilized the error tolerance feature to design approximate neural networks or tolerate logical faults. However, besides high-level faults or noises, timing errors induced by delay faults, process variations, aging, etc. are dominating the reliability of NN accelerator under nanoscale manufacturing process. In this paper, we leverage the error resiliency of neural network to mitigate timing errors in NN accelerators. Specifically, when timing errors significantly affect the output results, we propose to retrain the accelerators to update their weights, thus circumventing conventional timing errors. Experimental results show that timing errors in NN accelerators can be well tamed for different applications.

Download Paper (PDF; Only available from the DATE venue WiFi)

IP2-4 DICTIONARY-BASED SPARSE REPRESENTATION FOR RESOLUTION IMPROVEMENT IN LASER VOLTAGE IMAGING OF CMOS INTEGRATED CIRCUITS

Speakers: Tenzile Berkin Cilingiroglu, Mahmoud Zangeneh, Aydan Uyar, W. Clem Karin, Janusz Konrad, Ajay Joshi, Bennett B. Goldberg and M. Selim Uluslu, Boston University, US

Abstract
The rapid decrease in the dimensions of integrated circuits with a simultaneous increase in component density have introduced resolution challenges for optical failure analysis tech-niques. Although optical microscopy efforts continue to increase resolution of optical systems through hardware modifications, signal processing methods are essential to complement these efforts to meet the resolution requirements for the nanoscale integrated circuit technologies. In this work, we focus on laser voltage imaging as the optical failure analysis technique and show how an overcomplete dictionary-based sparse representation can improve resolution and localization accuracy. We describe a reconstruction approach based on this sparse representation and validate its performance on simulated data. We achieve an 80% reduction of the localization error.

Download Paper (PDF; Only available from the DATE venue WiFi)

IP2-5 FAULT-BASED ATTACKS ON THE BEL-T BLOCK CIPHER FAMILY

Speakers: Philipp Jovanovic and Ilija Polian, University of Passau, DE

Abstract
We present the first fault-based attack on the Bel-T block cipher family which has been adopted recently as a national standard of the Republic of Belarus. Our attack successfully recovers the secret key of the 128-bit, 192-bit and 256-bit versions of Bel-T using 4, 7 and 10 fault injections, respectively. We also show the results from our comprehensive simulation-based experiments.

Download Paper (PDF; Only available from the DATE venue WiFi)

IP2-6 ON THE PREMISES AND PROSPECTS OF TIMING SPECULATION

Speakers: Rong Ye1, Feng Yuan2, Jie Zhang2 and Qiang Xu2
1 Imperial College, GB; 2 The Chinese University of Hong Kong, HK

Abstract
Timing speculation (TS), being able to detect and correct circuit timing errors at runtime, is a promising alternative solution to mitigate the ever-increasing variation effects in nanometer circuits. The potential energy-efficiency improvement, however, is limited by the circuit "timing wall", a critical operating point caused by conventional circuit optimization techniques (e.g., gate sizing). With a given circuit netlist, we study the bound of the potential benefits provided by TS techniques in this work, which facilitate designers to decide whether it worths the effort to implement a timing-speculative circuit. Experimental results on benchmark circuits demonstrate the effectiveness of the proposed methodology.

Download Paper (PDF; Only available from the DATE venue WiFi)

IP2-7 IMPACT OF INTERCONNECT MULTIPLE-PATTERNING VARIABILITY ON SRAMS

Speakers: Ioannis Karageorgois1, Michele Stucchi2, Praveen Raghavan2, Julien Ryckaert2, Zsolt Tokei2, Diederik Verkest2, Rogier Baert2, Sushil Sakhare4 and Wim Dehaene3
1 imec; 2 IMEC; 3 KU Leuven, imec; BE

Abstract
The introduction of Multiple Patterning (MP) in sub-32nm technology nodes may pose severe variability problems in wire resistance and capacitance of IC circuits. In this paper we evaluate the impact of this variability on the performance of SRAM cell arrays based on the 10nm technology node, for a relevant range of process variation assumptions. The MP options we consider are the triple Litho-Etch (LE3) and the Self Aligned Double Patterning (SADP), together with Single Patterning Extreme-UV (EUV). In addition to the analysis of the worst-case variability scenario and the impact on SRAM performance, we propose an analytical formula for the estimation of SRAM read time penalty, using the RC variation of the bit line and the array size as input parameters. This formula, verified with SPICE simulations, allows a fast extraction of the statistical distribution of the read time penalty, using the Monte-Carlo method. Results on each patterning option are presented and compared.

Download Paper (PDF; Only available from the DATE venue WiFi)

IP2-8 COHERENCE BASED MESSAGE PREDICTION FOR OPTICALLY INTERCONNECTED CHIP MULTIPROCESSORS

Speakers: Anouk Van Laer1, Chamath Ellawala2, Muhammad Kidwan Madarbux1, Timothy M. Jones2 and Philip M. Watts1
1 University College London, GB; 2 University of Cambridge, GB

Abstract
Photonic networks on chip have been proposed to reduce latency and power consumption of on-chip communication in chip multiprocessors. However, in switched photonic networks, the path setup latency can create a high overhead, particularly for the short messages generated by shared memory chip multiprocessors (CMP). This has led to proposals for networks which avoidswitching using all-to-all or single writermultiple reader (SWMR) networks which dramatically increase optical component counts and hence power consumption. In this work we propose a predictor which uses information from the coherence protocol and previously transmitted messages to predict future messages and hence hide the path setup latency by speculatively setup photonic paths. We show that a directly mapped predictor can significantly speed up messages to predict future messages and hence hide the path setup latency by speculatively setup photonic paths. We show that a directly mapped predictor can significantly speed up message delivery and hence reduce the performance overhead.

Download Paper (PDF; Only available from the DATE venue WiFi)

IP2-9 OPENMP AND TIMING PREDICTABILITY: A POSSIBLE UNION?

Speakers: Roberto Vargas1, Eduardo Quinones2 and Andrea Marongiu3
1 Barcelona Supercomputing Center (BSC) and Technical University of Catalonia (UPC), ES; 2 Barcelona Supercomputing Center (BSC), ES; 3 Swiss Federal Institute of Technology in Zurich (ETHZ), CH

Abstract
Next-generation many-core embedded platforms have the chance of intercepting a converging need for high performance and predictability. Programming methodologies for such platforms will have to promote predictability as a first-class design constraint, along with features for massive parallelism exploitation. OpenMP, increasingly adopted in the embedded systems domain, has recently evolved to deal with the programmability of heterogeneous many-cores, with mature support for fine-grained task parallelism. While tasking is potentially very convenient for coding real-time applications modeled as periodic task graphs, OpenMP adopts an execution model completely agnostic to any timing requirement that the target application may have. In this position paper we reason about the suitability of the current OpenMP v4 specification and execution model to provide timing guarantees in many-cores.

Download Paper (PDF; Only available from the DATE venue WiFi)
IP2-10 (Best Paper Award Candidate)
**SAHARA: A SECURITY-AWARE HAZARD AND RISK ANALYSIS METHOD**

**Speakers:**
Georg Macher¹, Harald Sporer¹, Reinhard Berlach¹, Eric Armengaud² and Christian Kreiner¹

¹Graz University of Technology, AT; ²AVL List GmbH, AT

**Abstract**
Safety and Security appear to be two contradicting overall system features, which challenge researchers for decades. Traditionally, these two features have been treated separately, but due to increasing awareness of mutual impacts, cross domain knowledge and fine grasp of commonalities becomes more important. Due to increasing interlacing of systems (such as Car2x in the automotive domain), it is no longer acceptable to assume systems immune from security risks and vice versa. Future automotive systems require appropriate systematic approaches to support security aware safety development. Therefore, this paper presents a combined approach of the automotive HARA (hazard analysis and risk assessment) with the security domain STRIDE approach to trace impacts of security issues on safety concepts on system level. We present an approach to classify the probability of security threats to determine the appropriate amount of countermeasures to be considered. Furthermore, we analyze the impact of these security threats on safety analysis of automotive systems. The paper describes how such a method has been developed based on the HARA approach and how a safety-critical contribution of successful security attacks can be quantified and proceeded.

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**IP2-11**
**CYBERPHYSICAL-SYSTEM-ON-CHIP (CPSoC) : A SELF-AWARE MPSoC PARADIGM WITH CROSS-LAYER VIRTUAL SENSING AND ACTUATION**

**Speakers:**
Nikil Dutt¹, Puneet Gupta, Nanil Venkatasubramanian¹ and Alex Nicolau¹

¹University of California Irvine, US; ²University of California Los Angeles, US; ³University of California Berkeley, US; ⁴AVL List GmbH, AT

**Abstract**
Cyber-physical systems (CPSs) are physical and engineered systems whose operations are monitored, coordinated, controlled, and integrated by a computing, control, and communication core. We propose Cyberphysical-System-on-Chips (CPSoCs), a new class of sensor and actuator-rich multiprocessor systems-on-chip (MPSoCs), that augment MPSoCs with additional on-chip and cross-layer sensing and actuation capabilities to enable self-awareness within the observe-decide-act (ODA) paradigm. Unlike traditional MPSoC designs, CPSoC differs primarily on the co-design of computing-communication-control (C3) systems that interacts with the physical environment in real-time in order to adapt system behavior so as to dynamically react to environmental changes while achieving overall design goals. We illustrate CPSoC’s potential through a virtual sensor network that accurately estimates run-time power for variability affected subsystems using noisy thermal sensors in improving system goals and Quality-of-Service (QoS).

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**IP2-12**
**OCCUPANCY DETECTION VIA IBEECON ON ANDROID DEVICES FOR SMART BUILDING MANAGEMENT**

**Speakers:**
Andrea Corna, Lorenzo Fontana, Alessandro Antonio Nacci and Donatella Sciuto, Politecnico di Milano, IT

**Abstract**
Building heating, ventilation, and air conditioning (HVAC) systems are considered to be the main target for energy reduction due to their significant contribution to commercial buildings’ energy consumption. Knowing a building’s occupancy plays a crucial role in implementing demand-response HVAC. In this paper we propose a new solution based on the iBeacon technology. This solution is different from the previous ones because it leverages on the Bluetooth Low Energy standard, which provides lower power consumption. Moreover, the iBeacon protocol can be used both on iOS systems and Android ones, making this new approach portable. Differently from our previous work based on iOS devices, in this paper we focus on an Android based solution with the aim of increasing the accuracy of the location and the energy efficiency of the entire system. We increased the accuracy by 10% and the energy efficiency by 15%.

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**IP2-13**
**A NEURAL MACHINE INTERFACE ARCHITECTURE FOR REAL-TIME ARTIFICIAL LOWER LIMB CONTROL**

**Speakers:**
Jason Kane, Qing Yang, Robert Hernandez, Willard Simouneau and Matthew Seaton, University of Rhode Island, US

**Abstract**
Our new design and implementation paves the way for future bionic legs that require high speed real-time deterministic response, high accuracy, easy portability, and low power consumption. A working FPGA-based prototype has been built, and experiments have shown that it achieves average performance gains of around 8x that of the equivalent software algorithm running on an Intel Core i7 2.67GHz, or 24x that of an Intel Atom Z530 with no perceivable loss in accuracy. Furthermore, our fully pipelined and parallel non-linear support vector machine-based FPGA implementation led to a 6.4x speedup over an equivalent GPU-based design. In this paper, we also characterize our achieved timing margin to show that our design is capable of supporting real-time wireless communications. With additional refinement, such a wireless personal area network (PAN) system will provide improved flexibility on an individual basis for electromyography (EMG) sensor placement.

Download Paper (PDF; Only available from the DATE venue WiFi)
UB05.1 A FRAMEWORK FOR THE EMULATION AND PROTOTYPING OF NANO-PHOTONIC OPTICAL ACCELERATORS

Presenter:
Alberto Garcia-Ortiz, University of Bremen, DE

Authors:
Wolfgang Büter1, A. Ali2, S. Mahmoud2, S. Arefin3, V. V. Parsi Sreenivas4, M. Mike Büters1 and R.-B. Bergmann5
1Institute for Electrodynamics and Microelectronics Systems (ITEM), DE; 2University of Bremen, Physics/Electrical Engineering, DE; 3Bremer Institut für angewandte Strahltechnik GmbH, DE

Abstract
The recent advances in on-chip optical communication anticipate nano-photonic optical computing as a disruptive new technology. Different architectural solutions and competing physical implementations are currently being investigated. They include a wide spectrum of approaches such as those based on optical analog processing (e.g., nano-photonic optical vector-matrix multiplication), digital optical gates (e.g. reversible nano-photonic gates, BDD-based approaches, etc) or even quantum computing. Since the computing, performance, and error characteristics of these technologies differ substantially from those of standard CMOS technologies, an early co-design framework for nano-photonic accelerators embedded with digital multiprocessor systems is urgently required. It should allow an early investigation about the possible implementation of some kernels using optical accelerators and the effect of optical non-idealities in the overall system. This demo presents a framework for the virtual emulation and prototyping of nano-photonic accelerators for optical analog processing and digital optical gates, currently being developed at the "Institute of Electrodynamics and Microelectronics" (ITEM) and at the "Bremen Institute for Applied Beam Technology" (BIAS). This framework, based on the ideas of rapid prototyping and virtual emulation using FPGA technology, provides two levels of operation. At a first level, it offers a library of models that can be used to construct a virtual prototype of a hybrid multi-processor and nano-photonic system. The parameterizable models emulate several optical non-idealities but are synthesizable at the RTL-level, so that a standard FPGA-emulation of the complete system can be carried out. In a second level, it offers the possibility to plug-in a macrosopic optical accelerator to prototype the nano-photonic one with higher accuracy. In order to illustrate these two levels of operation, the demo at the DATE University-Booth will be twofold. Virtual emulation demo In the first demo, the user can define the functionality of the optical accelerator. Using a reversible-toolchain based on the RevKit tools by the "Computer Architecture and Reliable Embedded Systems" (AGRA), a reversible implementation is created. The structural reversible implementation is transformed into a nano-photonic model which is emulated in a FPGA. The final system, composed by a standard processor communicating with the nano-photonic model of the accelerator, can be programmed in C so that the user can study the impact of the accelerator in its algorithm. Physical prototype-demo This demo focuses on the prototype of a low-cost vector-matrix multiplication core using optical processing. The optical prototype is composed by a sandwich of two LCD structures with orthogonal polarizations sending an image to an integrated camera. The different elements are controlled by a hardware IP and connected to an embedded processor. The user can define several parameters of the optical processor, such as the spot-size, the photo-detector pitch etc. The physical prototype is then configured to that mode, and used as an optical accelerator by a microprocessor embedded in a FPGA. Again the user can program some C algorithms to study the system performance. Additionally a link to Matlab® allows the analysis of the precision achieved by the optical vector-matrix-multiplication process.

More information ...

UB05.2 ODEN: ASSERTION MINING FOR BEHAVIORAL DESCRIPTIONS

Presenter:
Alessandro Danese, University of Verona, IT

Authors:
Alessandro Danese, Tara Ghasempouri and Graziano Pravadelli, University of Verona, IT

Abstract
Specification mining is an automatic approach for extracting assertions from the implementation of the system under verification (SUV). Its primary goal is to improve the verification and documentation process by making available a matching between a manual definition of the expected functionality and a formalization of the actual implemented functionality. In order to automatically extract assertions, some approaches perform a static analysis of the SUV source code. These solutions, despite of their effectiveness, suffer of scalability problems. To overcome this drawback, dynamic approaches have been also proposed that extract assertions by relying only on the observation of SUV’s execution traces. This guarantees a better scalability, even if only “likely true assertions” can be extracted. For this reason a qualification phase is generally implemented in order to discard irrelevant and spurious assertions. In this context, ODEN is a tool for dynamically extracting likely true assertions by combining static and dynamic techniques. ODEN works with both hardware design and software applications. The tools analyses the execution traces of the system under verification and it generates assertions in the form of assertions under temporal relationships between arithmetic/logic expressions over the variables of the SUV. With respect to existing tools, ODEN works on a wider range of abstraction levels (e.g., gate-level, RTL, TLM, SW level, ...) and it considers a wider set of temporal patterns to more precisely characterize the behaviours of the SUV.

More information ...

UB05.3 WHERE IS IT? FIND THE CODE YOU ARE INTERESTED IN!

Presenter:
Jan Malburg, University of Bremen, DE

Author:
Görschwin Fey, University of Bremen / German Aerospace Center, DE

Abstract
The demonstration presents our tool for feature localization and debugging of RTL-designs. Feature localization helps a designer to find the code relevant for a certain feature and, thus, helps him to faster understand a design previously unknown to him. The developer can choose between three basic techniques for feature localization. In the area of debugging the tools allows fault localization, reverse debugging based on dynamic data- and control-flow of the design and dynamic slicing.

More information ...

UB05.4 STRNG: A SELF-TIMED RING BASED TRUE RANDOM NUMBER GENERATOR WITH MONITORING AND ENTROPY ASSESSMENT

Presenter:
Abdelkarim Cherkaoui, TIMA, FR

Authors:
Laurent Fesquet1, Viktor Fischer2 and Alain Aubert2
1TIMA, FR; 2LaHC, FR

Abstract
The self-timed ring based True Random Number Generator (STRNG) leverages the jitter of events propagating in a self-timed ring to generate provably random binary sequences. Several implementations in FPGAs and in CMOS design flows have shown the feasibility of this generator in digital technologies, and also confirmed that it can provide high quality random bit sequences that pass the standard statistical test batteries at rates as high as 200 Mbit/s. Following AIS31 recommendations for the design and evaluation of TRNGs, the security of this generator is based primarily on an entropy assessment obtained by modeling the entropy extraction and measuring the entropy source. Secondly, the generator is protected against active attacks by monitoring its behavior in real-time or on demand. In this demonstration, we illustrate this approach in an Altera Cyclone III implementation of the STRNG. We show how the design is configured depending on the measurement of the entropy source (the jitter magnitude) in order to guarantee a given minimum entropy output per bit. Then, we emulate physical attacks on the generator by willingly manipulating its internal structure in order to demonstrate how the entropy monitoring can detect abnormal behaviors and send the appropriate alarms.

More information ...
FUNCTIONAL ECO: AN EFFICIENT REWIRING ENHANCED FUNCTIONAL ECO

Abstract

Bugs and/or specification changes often happen in late design cycles. Running the whole design cycle again is time consuming and costly. Functional engineering change order (ECO), which is the process that patches an old implementation to accomplish a new specification, is therefore performed instead to save time and cost. In an ECO effort, minimizing the patch size is crucial since it gives a higher chance of successful insertion and analysis.

More information ...

OSTC: COMBINING HIFSUITE AND SCNSL FOR SMART DEVICE INTEGRATION AND SIMULATION

Abstract

The main design issue of smart devices is their high degree of heterogeneity, due to the simultaneous presence of multiple domains and extra-functional properties, together with the traditional system functionality. This makes design and simulation very challenging, even because heterogeneity implies that the functionality is not the only dimension that must be considered at validation time. Other properties, such as power consumption or thermal dissipation, are critical to ensure correctness of the final product and to correctly estimate its behavior. This makes component integration and simulation key phases in the design and verification process of smart devices. Thus, to efficiently master smart device design, it is fundamental to be aware of design issues and to know how to solve them through innovative tools and methods.

More information ...

VDA-ADMF: AN AGILE MIGRATION FRAMEWORK FOR ANALOG LAYOUT DESIGN

Abstract

In our framework, a reference analog layout design is given to generate potential layout candidates at the objective technology. The demonstration includes the original layout, the extracted topology with placement and routing, the generated layout figures, the dumped layout results and the simulated results.

More information ...

VDA-ADMF: AN AGILE MIGRATION FRAMEWORK FOR ANALOG LAYOUT DESIGN

Abstract

Layout generation in the late analog CMOS design is challenging by its increasing layout constraints and performance requirements. However, iterative refinement on manual design damages the productivity of analog layout. Therefore, it is more efficient to enroll the know-how from existing design instead of generating a new one. To contend with time-consuming analog layout for more properties, this software aims to demonstrate a fast layout prototyping framework for migration purpose into real layout design. In our framework, a reference analog layout design is given to generate potential layout candidates at the objective technology. The demonstration includes the original layout, the extracted topology with placement and routing, the generated layout figures, the dumped layout results and the simulated results.

More information ...

OSTC: COMBINING HIFSUITE AND SCNSL FOR SMART DEVICE INTEGRATION AND SIMULATION

Abstract

Selecting an appropriate and efficient test flow for a 2.5D/3D Stacked IC (2.5D-SIC/3D-SIC) is crucial for overall cost optimization. In this demonstration, we present 3D-COSTAR, a tool that considers costs involved in the whole 2.5D/3D-SIC chain, including design, manufacturing, test, packaging and logistics, e.g. related to shipping wafers between a foundry and a test house; and provides the estimated overall cost for 2.5D/3D-SICs and its cost breakdown for a given input parameter set, e.g., test flows, die yield and stack yield. Several case studies will be presented in which the overall cost and product quality (in defective parts per million) are analyzed.

More information ...

VDA-ADMF: AN AGILE MIGRATION FRAMEWORK FOR ANALOG LAYOUT DESIGN

Abstract

This procedure of migration provides a convincing exhibition of our migration framework.

More information ...

OSTC: COMBINING HIFSUITE AND SCNSL FOR SMART DEVICE INTEGRATION AND SIMULATION

Abstract

The main design issue of smart devices is their high degree of heterogeneity, due to the simultaneous presence of multiple domains and extra-functional properties, together with the traditional system functionality. This makes design and simulation very challenging, even because heterogeneity implies that the functionality is not the only dimension that must be considered at validation time. Other properties, such as power consumption or thermal dissipation, are critical to ensure correctness of the final product and to correctly estimate its behavior. This makes component integration and simulation key phases in the design and verification process of smart devices. Thus, to efficiently master smart device design, it is fundamental to be aware of design issues and to know how to solve them through innovative tools and methods, which allow integrating all the components of a smart device into an efficient and flexible simulation platform. We addressed such issues by means of the combined use of HiPSuite tools and SCNSL to obtain a homogeneous and fast SystemC/C++ model of a smart device through the compositions of heterogeneous components. An Open Source Test Case (OSTC) has been defined to show the potentiality of the proposed methods and tools.

More information ...

VDA-ADMF: AN AGILE MIGRATION FRAMEWORK FOR ANALOG LAYOUT DESIGN

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More information ...

VDA-ADMF: AN AGILE MIGRATION FRAMEWORK FOR ANALOG LAYOUT DESIGN

Abstract

This procedure of migration provides a convincing exhibition of our migration framework.

More information ...

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Abstract

This procedure of migration provides a convincing exhibition of our migration framework.
12:30 Lunch Break, Keynote lectures from 1250 - 1420 (Room Oisans) in front of the session room Salle Oisans and in the Exhibition area

Coffee Break in Exhibition Area

On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area.

Lunch Break

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Tuesday, March 10, 2015
Coffee Break 10:30 - 11:30
Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
Coffee Break 16:00 - 17:00

Wednesday, March 11, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)
Coffee Break 16:00 - 17:00

Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

6.1 SPECIAL DAY Hot Topic: Platforms for the IoT

Date: Wednesday 11 March 2015
Time: 11:00 - 12:30
Location / Room: Salle Oisans

Organisers:
Rolf Drechsler, University of Bremen/DFKI GmbH, DE
Christoph Grimm, University of Kaiserslautern, DE

Chair:
Christoph Grimm, University of Kaiserslautern, DE

Co-Chair:
Marie-Minerve Louerat, University of Paris, FR

The pervasive networking of embedded systems enables the vision of the “Internet of Things”. Appliances are built on top of and using hardware, software, and communication platforms. The presentations in this session cover the new and challenging requirements: The first presentation gives a visionary overview of how platforms will be used in an open, dynamic and organic way. To make these visions happen right now, technical challenges are addressed: in the second presentation, energy-awareness electronic platforms are in the focus. In the third presentation, an overview of software architectures for the IoT is given. Last but not least, standardized networking at semantic layer is required to enable machine-to-machine (M2M) communication and intelligent service discovery.

<table>
<thead>
<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:00</td>
<td>6.1.1</td>
<td>THE HUMAN INTRANET: WHERE SWARMS AND HUMANS MEET</td>
<td>Jan Rabaey, UC Berkeley, US</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abstract</td>
<td>A Human Intranet is envisioned as an open scalable platform that seamlessly integrates an ever-increasing number of sensor, actuation, computation, storage, communication and energy nodes located on, in, or around the human body acting in symbiosis with the functions provided by the body itself. This may fundamentally alter the ways humans operate, and interact with the physical world around them. It all starts with concepts that find their roots in the Internet of Things (IoT) and swarm technologies.</td>
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<td>Download Paper (PDF; Only available from the DATE venue WiFi)</td>
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<tr>
<td>11:22</td>
<td>6.1.2</td>
<td>ENERGY EFFICIENT ELECTRONICS FOR THE INTERNET OF THINGS</td>
<td>Stefan Heinen, RWTH Aachen, DE</td>
</tr>
<tr>
<td>11:44</td>
<td>6.1.3</td>
<td>SOFTWARE ARCHITECTURES FOR THE INTERNET OF THINGS</td>
<td>Mario Trapp, FhG IESE, DE</td>
</tr>
<tr>
<td>12:06</td>
<td>6.1.4</td>
<td>ONEM2M : A STANDARD FOR AN OPEN AND INTEROPERABLE M2M PLATFORM, THANKS TO SEMANTIC WEB TOOLS</td>
<td>Marylin Arndt-Vincent, Orange Labs, FR</td>
</tr>
</tbody>
</table>
Time | Label | Presentation Title | Authors
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12:30 | End of session | Lunch Break, Keynote lectures from 1250 - 1420 (Room Oisans) in front of the session room Salle Oisans and in the Exhibition area Coffee Break in Exhibition Area
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Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

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6.2 Physical Unclonable Functions

**Date:** Wednesday 11 March 2015
**Time:** 11:00 - 12:30
**Location / Room:** Belle Etoile

**Chair:**
Ingrid Verbauwhede, KUL, BE

**Co-Chair:**
Tim Güneysu, Ruhr University Bochum, DE

Physically Unclonable Functions (PUF) have received much attention for fingerprinting and as secret key provider in electronic devices. This session presents novel constructions and attacks on Arbiter, Ring-Oscillator and DRAM PUFs.

<table>
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<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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</table>
| 11:00 | 6.2.1 | EFFICIENT ATTACKS ON ROBUST RING OSCILLATOR PUF WITH ENHANCED CHALLENGE-RESPONSE SET | Phuong Ha Nguyen, Durga Prasad Sahoo, Rajat Subhra Chakraborty and Debdeep Mukhopadhyay, Indian Institute of Technology Kharagpur, IN

**Abstract**
Physically Unclonable Function (PUF) circuits are an important class of hardware security primitives that promise a paradigm shift in applied cryptography. Ring Oscillator PUF (ROPUF) is an important PUF variant, but it suffers from hardware overhead limitations, which in turn restricts the size of its challenge space. To overcome this fundamental shortcoming, improved ROPUF variants based on the subset selection concept have been proposed, which significantly expand the challenge space of a ROPUF at acceptable hardware overhead. In this paper, we develop cryptanalytic attacks on previously proposed low-overhead and robust ROPUF variant. The proposed attacks are practical as they have quadratic time and data complexities in the worst case. We demonstrate the effectiveness of the proposed attack by successfully attacking a public domain dataset acquired from FPGA implementations.

| Download Paper (PDF; Only available from the DATE venue WiFi) |

| 11:30 | 6.2.2 | A ROBUST AUTHENTICATION METHODOLOGY USING PHYSICALLY UNCLONABLE FUNCTIONS IN DRAM ARRAYS | Maryam S. Hashemian¹, Bhanu Singh¹, Francis Wolff¹, Chris Papachristou¹, Steve Clay² and Daniel Weyer²

¹Case Western Reserve University, US; ²Rockwell Automation, US

**Abstract**
The high availability of DRAM in either embedded or stand-alone form make it a target for counterfeit attacks. In this paper, we propose a robust authentication methodology against counterfeiting. The authentication is performed by exploiting the intrinsic process variation in write reliability of DRAM cells. Extensive Monte Carlo simulations performed in HSPICE show that the proposed authentication methodology provides high uniqueness of 50.01% average inter-die Hamming distance and good robustness under temporal fluctuations in supply voltage, temperature, and ageing effect over a 10-year lifetime.

| Download Paper (PDF; Only available from the DATE venue WiFi) |

| 12:00 | 6.2.3 | A NOVEL MODELING ATTACK RESISTANT PUF DESIGN BASED ON NON-LINEAR VOLTAGE TRANSFER CHARACTERISTICS | Arunkumar Vijayakumar and Sandip Kundu, Department of Electrical and Computer Engineering, University of Massachusetts, Amherst, US

**Abstract**
Physical Unclonable Function (PUF) circuits are used for chip authentication. PUF designs rely on manufacturing process variations to produce unique response to input challenges. It has been shown that many PUF designs are vulnerable to machine learning (ML) attacks, where a model can be built to predict PUF response to any input after only a few observations. In this work, we propose a ML attack resistant PUF design based on a circuit block to implement a non-linear voltage transfer function. The proposed circuit is simple, exhibits high uniqueness and randomness. Further improvements are proposed to enhance PUF reliability. The proposed circuit was simulated in a 45nm technology process and the results indicate a significant improvement in ML attack resistance in comparison to traditional PUFs. Results on uniqueness and reliability are also presented.

| Download Paper (PDF; Only available from the DATE venue WiFi) |
STT MRAM-BASED PUFs

Elena Ioana Vatajelu\textsuperscript{1}, Giorgio Di Natale\textsuperscript{2}, Marco Indaco\textsuperscript{1} and Paolo Prinetto\textsuperscript{1}
\textsuperscript{1}Politecnico di Torino, IT; \textsuperscript{2}LIRMM, FR

Abstract

Physical Uncloneable Functions (PUFs) are emerging cryptographic primitives used to implement low-cost device authentication and secure secret key generation. Weak PUFs (i.e., devices able to generate a single signature or able to deal with a limited number of challenges) are widely discussed in literature. Nowadays, the most promising solution is based on SRAMs. In this paper we propose an innovative PUF design based on STT-MRAM memory. We exploit the high variability affecting the electrical resistance of the MTJ device in anti-parallel magnetization. We will show that the proposed solution is robust, unclonable and unpredictable.

Download Paper (PDF; Only available from the DATE venue WiFi)

12:30
End of session

Lunch Break, Keynote lectures from 1250 - 1420 (Room Oisans)

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Coffee Break 15:30 - 16:00

6.3 Emerging Low Power Techniques

Date: Wednesday 11 March 2015
Time: 11:00 - 12:30
Location / Room: Stendhal

Chair:
Guillermo Payà Vayà, Leibniz Universität Hannover, DE

Co-Chair:
Alberto Garcia-Ortiz, U. Bremen, DE

Technology improvements towards the nanometric era are inducing new challenges which need to be addressed at all the abstraction levels. This section focuses on the latest emerging approaches to cope with those challenges, as for example approximate computing, compressed sensing, asymmetric underlapped FinFET, etc.

11:00 6.3.1 (Best Paper Award Candidate)
ASYMMETRIC UNDERLAPPED FINFET BASED ROBUST SRAM DESIGN AT 7NM NODE

Speaker:
Rangharajan Venkatesan, NVIDIA Corporation, US

Authors:
Arun Goud Akkala\textsuperscript{1}, Rangharajan Venkatesan\textsuperscript{2}, Anand Raghunathan\textsuperscript{1} and Kaushik Roy\textsuperscript{1}
\textsuperscript{1}Purdue University, US; \textsuperscript{2}NVIDIA Corporation, US

Abstract

Robust 6T SRAM design in 7nm technology node, at low supply voltage and rising leakage, requires ingenious design of FinFETs capable of providing reasonable Ion/Ioff ratio and acceptable short channel effects even under new leakage mechanisms such as direct source to drain tunneling. In this work, we explore asymmetric underlapped FinFET design with the help of quantum mechanical device simulations considering both the bit-cell and cache design constraints. We show that our optimized FinFET achieves a significant improvement in on-current over conventional symmetrically underlapped FinFETs. Through circuit simulations using compact models, we demonstrate that when such asymmetric underlapped n-FinFETs are used as bit-line access transistors, read/write conflict can be mitigated with simultaneous reduction in 6T SRAM bit-cell leakage. Improvement in write noise margin as well as access time can also be achieved under iso-read stability condition. Based on these technology and bit-cell models, we have developed a CACTI-based simulator for evaluating asymmetric FinFET based SRAM cache at 7nm node. Using this device-circuit-system level framework and optimized asymmetric underlapped FinFETs, we demonstrate significant energy savings and performance improvements for an 8KB L1 cache and a 4MB last-level cache.

Download Paper (PDF; Only available from the DATE venue WiFi)
QUALITY CONFIGURABLE REDUCE-AND-RANK FOR ENERGY EFFICIENT APPROXIMATE COMPUTING

Speakers:
Amar Raha, Swagath Venkataramani, Vijay Raghunathan and Anand Raghunathan, Purdue University, US

Abstract
Approximate computing is an emerging design paradigm that exploits the intrinsic ability of applications to produce acceptable outputs even when their computations are executed approximately. In this work, we explore approximate computing for a key computation pattern, Reduce-and-Rank (RnR), which is prevalent in a wide range of workloads including video processing, recognition, search and data mining. An RnR kernel performs a reduction operation (e.g., distance computation, dot product, L1-norm) between an input vector and each of a set of reference vectors, and ranks the reduction outputs to select the top reference vectors for the current input. We propose two complementary approximation strategies for the RnR computation pattern. The first is an interleaved reduction-and-ranking, wherein the vector reductions are decomposed into multiple partial reductions and interleaved with the rank computation. Leveraging this transformation, we propose the use of intermediate reduction results and ranks to identify future computations that are likely to have low impact on the output, and can hence be approximated. The second strategy, input similarity based approximation, exploits the spatial or temporal correlation of inputs (e.g., pixels of an image or frames of a video) to identify computations that are amenable to approximation. These strategies address a key challenge in approximate computing - identification of which computations to approximate - and may be used to drive any approximation mechanism such as computation skipping and precision scaling to realize performance or energy improvements. A second key challenge in approximate computing is that the extent to which computations can be approximated varies significantly from application to application, and across inputs for even a single application. Hence, quality configurability, or the ability to automatically modulate the degree of approximation at runtime is essential. To enable quality configurability in RnR kernels, we propose a kernel-level quality metric that correlates well to application-level quality, and identify key parameters that can be used to tune the proposed approximation strategies dynamically. We develop a runtime framework that modulates the identified parameters during execution of RnR kernels to minimize their energy while meeting a given target quality. To evaluate the proposed concepts, we designed quality-configurable hardware implementations of 6 RnR-based applications from the recognition, mining, search and video processing application domains in 45nm technology. Our experiments demonstrate 1.06X-2.18X reduction in energy consumption with virtually no loss in output quality (<0.5%) at the application-level. The energy benefits further improve up to 2.38X and 2.5X when the quality constraints are relaxed to 2.5% and 5% respectively.

Download Paper (PDF; Only available from the DATE venue WiFi)

ULTRA-LOW-POWER ECG FRONT-END DESIGN BASED ON COMPRESSED SENSING

Speakers:
Hossein Mamaghanian1 and Pierre Vanderheyden2
1EPFL, CH; 2École Polytechnique Fédérale de Lausanne (EPFL), CH

Abstract
Ultra-low-power design has been a challenging area for design of the sensor front-ends especially in the area of Wireless Body Sensor Nodes (WBSN), where a limited amount of power budget and hardware resources is available. Since introduction of CS, there has been a huge challenge to design CS readout devices for different applications and among all for biomedical signals. Till now, different proposed realizations of the digital CS prove the suitability of using CS as a compression technique for compressible biomedical signals. However, these works mainly take advantages of only one aspect of the benefits of the CS. In this type of works, CS is usually used as a very low cost and easy to implement compression technique. This means that we should acquire the signal with traditional limitations on the bandwidth (BW) and later compresses it. However, the main power of the CS, which lies on the efficient data acquisition, remains untouched. Building on our previous work [1], where the suitability of the CS is proven for the compression of the ECG signals, and our investigation on ultra-low-power CS-based AI2 devices [2], here in this paper we propose a fully redesigned complete CS-based “Analog-to-information” (A/I) front-end for ECG signals. Our results show that proposed hybrid design easily outperforms the traditional implementation of CS with more than 11 times fold reduction in power consumption in high compression ratio.

Download Paper (PDF; Only available from the DATE venue WiFi)

GTFUZZ: A NOVEL ALGORITHM FOR ROBUST DYNAMIC POWER OPTIMIZATION VIA GATE SIZING WITH FUZZY GAMES

Speakers:
Tony Casagrande and Nagarajan Ranganathan, University of South Florida, US

Abstract
As CMOS technology continues to scale, the effects of variation inject a greater proportion of error and uncertainty into the design process. Ultra-deep submicron circuits require accurate modeling of gate delay in order to meet challenging timing constraints. With the lack of statistical data, designers are faced with a daunting task to optimize a circuit which is greatly affected by variability due to the mechanical and chemical manufacturing process. Discrete gate sizing is a complex problem which requires (1) accurate models that take into account random parametric variation and (2) a fair allocation of resources to maximize the solution in the delay-energy space. The GTFUZZ algorithm is presented which handles both of these tasks. Fuzzy games are used to model the problem of gate sizing as a resource allocation problem. In fuzzy games, delay is considered a fuzzy goal with fuzzy parameters to capture the impression of gate delay early in the design phase when empirical data is absent. Dynamic power is normalized as a fuzzy goal without varying coefficients. The fuzzy goals also provide a flexible platform for multimetric optimization. The robust GTFUZZ algorithm is compared against fuzzy linear programming (FLP) and deterministic worst-case FLP (DWFCLP) algorithms. Benchmark circuits are first synthesized, placed, routed, and optimized for performance using the Synopsys University 32/28nm standard cell library and technology files. Operating at the optimized clock frequency, results show an average power reduction of about 20% versus DWFCLP and 9% against variation-aware gate sizing with FLP. Timing and timing yield are verified by both Synopsys PrimeTime and Monte Carlo simulations of the most critical paths using HSPICE.

Download Paper (PDF; Only available from the DATE venue WiFi)

SPATIAL AND TEMPORAL GRANULARITY LIMITS OF BODY BIASING IN UTBB-FDSOI

Speakers:
Johannes Maximilian Kühn1, Dustin Peterson1, Hideharu Amano2, Oliver Bringmann1 and Wolfgang Rosenstiel1
1Eberhard Karls Universität Tübingen, DE; 2Keio University, JP

Abstract
Advances in SOI technology such as STMicro’s 28nm UTBB-FDSOI enabled a renaissance of body biasing. Body biasing is a fast and efficient technique to change power and performance characteristics. As the electrical task to change the substrate potential is small compared to Dynamic Voltage Scaling, much finer island sizes are conceivable. This however creates new challenges in regard to design partitioning into body bias islands and body bias combinations across such designs. These combinations should be chosen so that energy efficiency improves while maintaining timing constraints. We introduce a combination based analysis tool to find optimized body bias island partitions and body biasing levels. For such partitions, optimized body bias assignments for static, programmable and dynamic body biasing can be computed. The algorithms were developed with the help of dynamically body biased test benches are estimated to yield actual improvements and to give an upper bound for the power consumption of required additional circuitry. Based on these partitions and the switching overheads, optimized application specific switching strategies are computed. The effectiveness of this method is demonstrated in a frequency scaling scenario using forward body biasing on a Dynamic Reconfigurable Processor (DRP) design. We show that leakage can be greatly reduced using the proposed methods and that dynamic body biasing can be beneficial even at small time periods.

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Thursday, March 12, 2015

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00

### 6.4 Bridging the Moore’s Law Gap with Application-Specific Architectures

**Date:** Wednesday 11 March 2015  
**Time:** 11:00 - 12:30  
**Location / Room:** Chartreuse

**Chair:** Cristina Silvano, Politecnico di Milano, IT  
**Co-Chair:** Akash Kumar, National University of Singapore, SG

This session focuses on approximation, low-power, and high-performance optimization techniques for application-specific architectures, including neural networks, multicore and GPUs.

<table>
<thead>
<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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</table>
| 11:00 | 6.4.1 | A ULTRA-LOW-ENERGY CONVOLUTION ENGINE FOR FAST BRAIN-INSPIRED VISION IN MULTICORE CLUSTERS | Francesco Conti\(^1\) and Luca Benini\(^2\)  
\(^1\)Università di Bologna, IT; \(^2\)Università di Bologna / ETH Zürich, IT  
**Abstract**  
State-of-art brain-inspired computer vision algorithms such as Convolutional Neural Networks (CNNs) are reaching accuracy and performance rivaling that of humans; however, the gap in terms of energy consumption is still many degrees of magnitude wide. Many-core architectures using shared-memory clusters of power-optimized RISC processors have been proposed as a possible solution to help close this gap. In this work, we propose to augment these clusters with Hardware Convolution Engines (HWCEs): ultra-low energy coprocessors for accelerating convolutions, the main building block of many brain-inspired computer vision algorithms. Our synthesis results in ST 28nm FDSOI technology show that the HWCE is capable of performing a convolution in the lowest-energy state spending as little as 35 pJ/pixel on average, with an optimum case of 6.5 pJ/pixel. Furthermore, we show that augmenting a cluster with a HWCE can lead to an average boost of 40x or more in energy efficiency in convolutional workloads. |

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</table>
| 11:30 | 6.4.2 | ELIMINATING INTRA-WARP CONFLICT MISSES IN GPU | Bin Wang, Zhuo Liu, Xinning Wang and Weikuan Yu, Auburn University, US  
**Abstract**  
Cache indexing functions play a key role in reducing conflict misses by spreading accesses evenly among all sets of cache blocks. Although various methods have been proposed, no significant effort has been expended on the behavior of conflict misses in GPU where threads are organized into warps and execute in lock-step. When intra-warp accesses could not be coalesced into one or two cache blocks, which is often referred to as memory divergence, a warp incurs up to SIMD-width (e.g., 32) independent cache accesses. Such a burst of divergent accesses not only increases contention on cache capacity, but also incurs intra-warp associativity conflicts when they are pathologically concentrated in a few cache sets. Due to the lock-step execution, the GPU Load/Store units would be stalled when intra-warp concentration exceeds available cache associativity. Through an in-depth analysis of GPU access patterns, we find that column-major ordered strides accesses are likely to incur high intra-warp concentration. Based on the analysis, we propose a Full Permutation (FUP) based indexing method that adapts to both large and medium strides in this pattern. Across the 10 highly cache-sensitive GPU applications we have evaluated, FUP eliminates intra-warp associativity conflicts and outperforms two state-of-the-art indexing methods by 22% and 15%, respectively. |

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<tr>
<td>12:00</td>
<td>6.4.3</td>
<td>RNA: A RECONFIGURABLE ARCHITECTURE FOR HARDWARE NEURAL ACCELERATION</td>
<td>Fengbin Tu¹, Shouyi YIN¹, Peng Ouyang¹, Leibo Liu² and Shaojun Wei¹ ¹Tsinghua University, CN; ²Institute of Microelectronics and The National Lab for Information Science and Technology, Tsinghua University, CN</td>
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</tbody>
</table>

**Abstract**
As the energy problem has become a big concern in digital system design, one promising solution is combining the core processor with a multi-purpose accelerator targeting high performance applications. Many modern applications can be approximated by multi-layer perceptron (MLP) models, with little quality loss. However, many current MLP accelerators have several drawbacks, such as the unbalance of their performance and flexibility. In this paper, we propose a scheduling framework to guide mapping MLPs onto limited hardware resources with high performance. The framework successfully solves the main constraints of hardware neural acceleration. Furthermore, we implement a reconfigurable neural architecture (RNA) based on this framework, whose computing pattern can be reconfigured for different MLP topologies. The RNA achieves comparable performance with application-specific accelerators and greater flexibility than other hardware MLPs.

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<tr>
<td>12:15</td>
<td>6.4.4</td>
<td>APPROXANN: AN APPROXIMATE COMPUTING FRAMEWORK FOR ARTIFICIAL NEURAL NETWORK</td>
<td>Qian Zhang, Ting Wang, Ye Tian, Feng Yuan and Qiang Xu, The Chinese University of Hong Kong, HK</td>
</tr>
</tbody>
</table>

**Abstract**
Artificial Neural networks (ANNs) are one of the most well-established machine learning techniques and have a wide range of applications, such as Recognition, Mining and Synthesis (RMS). As many of these applications are inherently error-tolerant, in this work, we propose a novel approximate computing framework for ANN, namely ApproxANN. When compared to existing solutions, ApproxANN not only considers approximation for the computational units, but also approximates memory accesses. To be specific, ApproxANN characterizes the impact of neurons on the output quality in an effective and efficient manner, and judiciously determine how to approximate the computation and memory accesses of certain less critical neurons to achieve the maximum energy efficiency gain under a given quality constraint. Experimental results on various ANN applications with different datasets demonstrate the efficacy of the proposed solution.

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<tr>
<td>12:30</td>
<td>6.4.3</td>
<td>A HARDWARE IMPLEMENTATION OF A RADIAL BASIS FUNCTION NEURAL NETWORK USING STOCHASTIC LOGIC</td>
<td>Yuan Ji¹, Feng Ran¹, Cong Ma² and David Lilja² ¹Shanghai University, CN; ²University of Minnesota - Twin Cities, US</td>
</tr>
</tbody>
</table>

**Abstract**
Hardware implementations of artificial neural networks typically require significant amounts of hardware resources. This paper proposes a novel radial basis function artificial neural network using stochastic computing elements, which greatly reduces the required hardware. The Gaussian function used for the radial basis function is implemented with a two-dimensional finite state machine. The norm between the input data and the center point is optimized using simple logic gates. Results from two pattern recognition case studies, the standard Iris flower and the MICR font benchmarks, show that the difference of the average mean squared error between the proposed stochastic network and the corresponding traditional deterministic network is only 1.3% when the stochastic stream length is 10kbits. The accuracy of the recognition rate varies depending on the stream length, which gives the designer tremendous flexibility to tradeoff speed, power, and accuracy. From the FPGA implementation results, the hardware resource requirement of the proposed stochastic hidden neuron is only a few percent of the hardware requirement of the corresponding deterministic hidden neuron. The proposed stochastic network can be expanded to larger scale networks for complex tasks with simple hardware architectures.

Download Paper (PDF; Only available from the DATE venue WiFi)

<table>
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<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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<tbody>
<tr>
<td>12:30</td>
<td>6.4.3</td>
<td>SODA: SOFTWARE DEFINED FPGA BASED ACCELERATORS FOR BIG DATA</td>
<td>Chao Wang, Xi Li and Xuehai Zhou, University of Science and Technology of China, CN</td>
</tr>
</tbody>
</table>

**Abstract**
SODA has been an emerging field in novel big data architectures and systems, due to its high efficiency and low power consumption. It enables the researchers to deploy massive accelerators within one single chip. In this paper, we present a software defined FPGA based accelerators for big data, named SODA, which could reconstruct and reorganize the acceleration engines according to the requirement of the various data-intensive applications. SODA decomposes large and complex applications into coarse grained single-purpose RTL code libraries that perform specialized tasks in out-of-order hardware. We built a prototyping system with constrained shortest path Finding (CSPF) case studies to evaluate SODA framework. SODA is able to achieve up to 43.75X speedup at 128 node application. Furthermore, hardware cost of the SODA framework demonstrates that it can achieve high speedup with moderate hardware utilization.

Download Paper (PDF; Only available from the DATE venue WiFi)

<table>
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<th>Time</th>
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<th>Presentation Title</th>
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<tr>
<td>12:30</td>
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<td>Lunch Break, Keynote lectures from 1250 - 1420 (Room Oisans) in front of the session room Salle Oisans and in the Exhibition area</td>
<td>Coffee Break in Exhibition Area  In front of the session room Salle Oisans and in the Exhibition area On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area.</td>
</tr>
</tbody>
</table>

**Lunch Break**
On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the Exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Ecrins (for fully registered conference delegates only).

**Tuesday, March 10, 2015**
Coffee Break 10:30 - 11:30
Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
Coffee Break 16:00 - 17:00

**Wednesday, March 11, 2015**
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:30; Keynote lectures from 12:50 - 14:20 (Room Oisans)
Coffee Break 16:00 - 17:00

**Thursday, March 12, 2015**
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00
6.5 Multimedia and Consumer Electronics

Date: Wednesday 11 March 2015
Time: 11:00 - 12:30
Location / Room: Meije

Chair: Muhammad Shafique, Karlsruhe Institute of Technology, DE
Co-Chair: Marcello Coppola, STMicroelectronics, FR

This session presents hardware and software architectures that enable effective implementations of multimedia and consumer electronics systems.

### 11:00 6.5.1 DRAM OR NO-DRAM? EXPLORING LINEAR SOLVER ARCHITECTURES FOR IMAGE DOMAIN WARPING IN 28 NM CMOS

**Speakers:**
Michael Schaffner¹, Frank K. Gürkanayk¹, Aljoscha Smolic² and Luca Benini²

¹Swiss Federal Institute of Technology in Zurich (ETHZ), CH; ²Disney Research Zurich, CH; ³Università di Bologna / Swiss Federal Institute of Technology in Zurich (ETHZ), CH

**Abstract**

Solving large optimization problems within the energy and cost budget of mobile SoCs in real-time is a challenging task and motivates the development of specialized hardware accelerators. We present an evaluation of different linear solvers suitable for least-squares problems emanating from image processing applications such as image domain warping. In particular, we estimate implementation costs in 28 nm CMOS technology, with focus on trading on-chip memory vs. off-chip (DRAM) bandwidth. Our assessment shows large differences in circuit area, throughput and energy consumption and aims at providing a recommendation for selecting a suitable architecture. Our results emphasize that DRAM-free accelerators are an attractive choice in terms of power consumption and overall system complexity, even though they require more logic silicon area when compared to accelerators that make use of external DRAM.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 11:30 6.5.2 A SMALL NON-VOLATILE WRITE BUFFER TO REDUCE STORAGE WRITES IN SMARTPHONES

**Speakers:**
Mungyu Son¹, Sungkwang Lee¹, Kyungho Kim², Sungsoo Yoo¹ and Sungu Lee¹

¹POSTECH, KR; ²Samsung Electronics, KR

**Abstract**

Storage write behavior in mobile devices, e.g., smartphones, is characterized by frequent overwrites of small data. In our work, we first demonstrate a small non-volatile write buffer is effective in coalescing such overwrites to reduce storage writes. We also present how to make the best use of write buffer resource the size of which is limited by the requirement of small form factor. We present two new methods, shadow tag and SQLite-aware buffer management both of which aim at identifying hot storage data to keep in the write buffer. We also investigate the storage behavior of multiple mobile applications and show that their interference can reduce the effectiveness of write buffer. In order to resolve this problem, we propose a new dynamic buffer allocation method. We did experiments with real mobile applications running on a smartphone and a Flash memory-based storage system and obtained average 56.2% and 50.2% reduction in storage writes in single and multiple application runs, respectively.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 12:00 6.5.3 CLUSTERING-BASED MULTI-TOUCH ALGORITHM FRAMEWORK FOR THE TRACKING PROBLEM WITH A LARGE NUMBER OF POINTS

**Speakers:**
Shih-Lun Huang, Sheng-Yi Hung and Chung-Ping Chen, Graduate Institute of Electronics Engineering, National Taiwan University, TW

**Abstract**

Microcontrollers (MCUs) are extensively used in consumer devices for specific purposes because they are tiny, cheap, and low-power. Any time-consuming algorithm and any large-size program are not suited for MCUs. Recently, we found that the conventional multi-touch algorithm becomes computationally expensive to handle the applications of large-sized touch panels. Although a more high-end MCU can obtain an improvement on speed, it would increase manufacturing cost and operating power consumption as well. In the whole multi-touch algorithm flow, point tracking is the most computationally expensive part. Fortunately, touch point tracking is similar to the pin-assignment problem in EDA. To accelerate tracking, we employ EDA techniques, such as clustering, to speed up our multi-touch algorithm. Besides, we prove that the tracking problem would be solved in O(n) time for practical cases and without losing its accuracy after clustering. Furthermore, we apply computational geometry techniques to develop an efficient clustering method. Experimental results show that clustering is efficient and effective. For the necessary requirement of large-area touch panels having 20 touch points, we can reduce the runtime by up to 70%. Besides, our multi-touch algorithm may support up to 80 touch points accompanied by a low-cost MCU.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 12:15 6.5.4 A LOW ENERGY 2D ADAPTIVE MEDIAN FILTER HARDWARE

**Speakers:**
Erkan Kalali and Ilker Hamzaoglu, Sabanci University, TR

**Abstract**

The two-dimensional (2D) spatial median filter is the most commonly used filter for image denoising. Since it is a non-linear sorting based filter, it has high computational complexity. Therefore, in this paper, we propose a novel low complexity 2D adaptive median filter algorithm. The proposed algorithm reduces the computational complexity of 2D median filter by exploiting the pixel correlations in the input image, and it produces higher quality filtered images than 2D median filter. We also designed and implemented a low energy 2D adaptive median filter hardware implementing the proposed 2D adaptive median filter algorithm. The proposed hardware is verified to work correctly on a Xilinx Zynq 7000 FPGA board. It can process 105 full HD (1920x1080) images per second in the worst case on a Xilinx Virtex 6 FPGA, and it has more than 80% less energy consumption than original 2D median filter hardware on the same FPGA.

Download Paper (PDF; Only available from the DATE venue WiFi)

### 12:30 6.5.5 DYNAMIC RECONFIGURABLE PUNCTURING FOR SECURE WIRELESS COMMUNICATION

**Speakers:**
Liang Tang¹, Jude Angelo Ambrose¹, Akash Kumar¹ and Sri Parameswaran²

¹National University of Singapore, SG; ²University of New South Wales, AU

**Abstract**

The ubiquity of wireless devices has created security concerns on the information being transferred. It is critical to protect the secret information in every layer of wireless communication to thwart any type of attacks. A dynamic reconfigurable puncturing based security mechanism, named RePunc, is proposed in this paper to provide an extra level of security at the physical layer. RePunc utilizes the puncturing feature of Forward Error Correction (FEC) to insert the secure information in the punctured positions of the standard information encoded data. The punctured patterns are dynamically changed and passed as a secret key from the sender to the receiver. An eavesdropper will not be able to detect the transmission of the secure information since the inserted secure information will be processed as channel noise by the eavesdropper’s receiver. However, the rightful receiver will be able to successfully decode the secure packets by knowingly differentiating the secure information and the standard information before the FEC decoding. A case study of RePunc implementation for WiFi communication is presented in this paper, showing the extreme high security complexity with low hardware overhead.

Download Paper (PDF; Only available from the DATE venue WiFi)
QR-DECOMPOSITION ARCHITECTURE BASED ON TWO-VARIABLE NUMERIC FUNCTION APPROXIMATION

Speakers:
Jochen Rust, Frank Ludwig and Steffen Paul, University of Bremen, DE

Abstract
This paper presents a new approach for hardware-based QR-decomposition using an efficient computation scheme of the Givens-Rotation. In detail, the angle of rotation and its application to the Givens-Matrix are processed in a direct, straight-forward manner. High-performance signal processing is achieved by piecewise approximation of the arctangent and sine function. In order to identify appropriate function approximations, several designs with varying constraints are automatically generated and analyzed. Physical and logical synthesis is performed in a 130nm CMOS-technology. The application of our proposal in a multi-antenna mobile communication scenario highlights our work to be very efficient in terms of calculation accuracy and computation performance.

IN-PLACE MEMORY MAPPING APPROACH FOR OPTIMIZED PARALLEL HARDWARE INTERLEAVER ARCHITECTURES

Speakers:
Saeed Ur Rehman1, Cyrille Chavet2, Philippe Coussy2 and Awais Sani1
1Lab-STICC / Université de Bretagne Sud, PK; 2Lab-STICC / Université de Bretagne Sud, FR

Abstract
Due to their impressive error correction performances, turbo-codes or LDPC (Low Density Parity Check) architectures are now widely used in communication system and are one of the most critical parts of decoders. In order to achieve high throughput requirements these decoders are based on parallel architecture, which results in a major problem to be solved: parallel memory access conflicts. To solve these conflicts, different approaches have been proposed in state of the art resulting in a lot of different architectural solutions. In this article, we introduce a new class of memory mapping approach that can solve the conflicts with an optimized architecture based on in-place memory mapping for any application.

6.6 Panel - The Future of Electronics, Semiconductor, and Design in Europe

Date: Wednesday 11 March 2015
Time: 11:00 - 12:30
Location / Room: Bayard

Organiser:
Marco Casale-Rossi, Synopsys, US

Chair:
Giovanni De Micheli, École Polytechnique Fédérale de Lausanne (EPFL), CH

For more than a decade, Europe has been the wireless continent; today, wireless has almost completely shifted to the U.S. and Asia. This shift has had a profound impact on the electronic, semiconductor, and design ecosystem: long-time leaders have disappeared, or have abandoned the wireless business/market. Europe needs to re-invent itself once again. Is there a future for electronics, and IC design and manufacturing in Europe? If so, what are the applications, and the technologies that will bring Europe back to the top of the world leadership? This panel session will gather executives from the semiconductor, IP, and R&D sectors to discuss the prospects of our industry in Europe.

Panelists:
- Giovanni De Micheli, École Polytechnique Fédérale de Lausanne (EPFL), CH
- Andrew Repton, -, US
- Thierry Collette, LETI, France, FR
- Antun Domic, Synopsys, US
- Horst Symanzik, Bosch Sensortec, DE
- Tony King-Smith, -, US
Lunch Break, Keynote lectures from 1250 - 1420 (Room Oisans) in front of the session room Salle Oisans and in the Exhibition area.

Coffee Break in Exhibition Area

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**Lunch Break**

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**Tuesday, March 10, 2015**

Coffee Break 10:30 - 11:30

Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics

Coffee Break 16:00 - 17:00

**Wednesday, March 11, 2015**

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)

Coffee Break 16:00 - 17:00

**Thursday, March 12, 2015**

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00

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**6.7 Application-Mapping Strategies for Many-Cores**

**Date:** Wednesday 11 March 2015  
**Time:** 11:00 - 12:30  
**Location / Room:** Les Bans

**Chair:**  
Amit Kumar Singh, University of York, GB

**Co-Chair:**  
Marc Geilen, Eindhoven University of Technology, NL

This session deals with application performance. The first paper proposes a performance model to guide run-time mapping. The other two papers optimize performance, one by mapping tasks to match the parallelism of the underlying architecture, and the other by identifying shared memory sections to facilitate parallel execution.

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<tr>
<td>11:00</td>
<td>6.7.1</td>
<td>ADAPTIVE ON-THE-FLY APPLICATION PERFORMANCE MODELING FOR MANY CORES</td>
<td>Sebastian Kobbe, Lars Bauer and Joerg Henkel, Karlsruhe Institute of Technology (KIT), DE</td>
</tr>
<tr>
<td>11:30</td>
<td>6.7.2</td>
<td>CUSTOMIZATION OF OPENCL APPLICATIONS FOR EFFICIENT TASK MAPPING UNDER HETEROGENEOUS PLATFORM CONSTRAINTS</td>
<td>Edoardo Paone¹, Francesco Robino², Gianluca Palermo¹, Vittorio Zaccaria¹, Ingo Sander² and Cristina Silvano¹</td>
</tr>
</tbody>
</table>

¹Politecnico di Milano, IT; ²KTH Royal Institute of Technology, SE

**Abstract**

Resource management for a many-core system entails allocating cores to applications and binding tasks of the applications to particular cores. Accurate on-the-fly estimates of different core allocations w.r.t. application performance are required before binding the tasks to cores for execution efficiency. We propose an adaptive on-the-fly application performance model that largely alleviates this increasingly important problem. It allows reacting to spontaneous workload variations and it considers topological properties of resources. Extensive evaluations show that the average estimation error is reduced from 14.7% to 4.5%, resulting in high quality of on-the-fly adaptive application mapping. Our work is a first milestone towards optimality of systems that exhibit a high degree of spontaneous workload variations.

**Download Paper (PDF; Only available from the DATE venue WiFi)**

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**Download Paper (PDF; Only available from the DATE venue WiFi)**
6.8 Panel - The Future of Electronics, Semiconductor, and Design in Europe -> takes place as session 6.6 in Salle Bayard

**Session 6.8 is part of the exhibition program open to all exhibition visitors, but takes place as session 6.6 in the larger room Bayard (no presentations in room Les Diguières). Please refer to session 6.6 for the details.**
12:30 End of session

**Lunch Break, Keynote lectures from 1250 - 1420 (Room Oisans)** In front of the session room Salle Oisans and in the Exhibition area

Coffee Break in Exhibition Area

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**Lunch Break**

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Coffee Break 10:30 - 11:30

Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics

Coffee Break 16:00 - 17:00

**Wednesday, March 11, 2015**

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)

Coffee Break 16:00 - 17:00

**Thursday, March 12, 2015**

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00

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### UB06 Session 6

**Date:** Wednesday 11 March 2015  
**Time:** 12:00 - 14:00  
**Location / Room:** University Booth, Booth 4, Exhibition Area

<table>
<thead>
<tr>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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</table>
| UB06.1 | SMART CELL DEVELOPMENT PLATFORM FOR EMBEDDED BATTERY MANAGEMENT | Swaminathan Narayanaswamy, TUM CREATE, SG  
Matthias Kauer¹, Sebastian Steinhorst¹, Martin Lukasiewycz¹ and Samarjit Chakraborty²  
¹TUM CREATE, SG; ²TU Munich, DE |

**Abstract**

Embedded Battery Management (EBM) [1], in contrast to the existing state-of-the-art centralized Battery Management Systems (BMSs) found in Electric Vehicles (EVs) or stationary Electrical Energy Storage (EES) applications, focuses on monitoring and controlling each individual cell of the battery pack with a dedicated Cell Management Unit (CMU). This novel approach of battery management might offer significant advantages over the centralized BMSs, such as higher modularity, plug-and-play integration and shorter time to market. The combination of a battery cell and a CMU forms the smart cell and the system-level functionalities of the EBM are performed in a decentralized manner by the network of smart cells, with the help of the computational and communication resources of CMUs. We present a development platform for such a smart cell enabled EBM. The development platform consists of two components, the hardware platform and the software platform. The hardware platform of the demonstrator comprises of battery cells and their dedicated CMUs which consist of a smart cell controller board and an active cell balancing board. The software platform provides the smart cell firmware as well as a software tool for verification of active cell balancing architectures and a smart cell simulator for simulating system-level EBM functionalities.

More information ...

| UB06.2 | ID.FIX: AN EDA TOOL FOR FIXED-POINT REFINEMENT OF EMBEDDED SYSTEMS | Olivier Sentieys, INRIA, FR  
Daniel Menard¹ and Nicolas Simon²  
¹INSA Rennes, FR; ²INRIA, FR |

**Abstract**

Most of digital image and signal processing algorithms are implemented into architectures based on fixed-point arithmetic to satisfy cost and power consumption constraints associated with most of embedded and cyber-physical systems. The fixed-point conversion process (or refinement) is crucial for reducing the time-to-market and design tools to automate this phase and to explore the design space are still lacking. The ID.Fix EDA tool, based on the compiler infrastructure GECOS, allows for the conversion of a floating-point C source code into a C code using fixed-point data types. The data word-lengths are optimized by minimizing the implementation cost under accuracy constraint. To achieve low optimization time, an analytical approach is used to evaluate the fixed-point computation accuracy. This approach is valid for systems made-up of any smooth arithmetic operations. Commercial tools can then be used to synthesize the architecture or to perform software compilation from the output fixed-point description of the application. Thus, the goal is to bridge the gap between the floating-point description developed by algorithm designer and the fixed-point description use as input for high-level synthesis or compilation tools.

More information ...

| UB06.3 | RSOC FRAMEWORK: FRAMEWORK FOR RAPID PROTOTYPING OF APPLICATIONS ON RECONFIGURABLE SOCs | Korcek Pavol, Brno University of Technology, CZ  
Jan Viktorin, Vlastimil Kosar and Jan Korenek, Brno University of Technology, CZ |

**Abstract**

Recent chips with ARM based processors and FPGA logic provide potential for many applications. IP cores and operating systems (OS) have been prepared to simplify development. However the integration of IP cores and OS is not covered by any development tool yet. We propose universal Reconfigurable System on Chip (RSoC) Framework to support rapid prototyping of different applications on these chips. Application can run in FPGA and/or in processor and RSoC Framework covers all mutual communication.

More information ...
UB06.4 REAL-TIME MULTIPROCESSOR COMPILER DEMO: COMPILER FOR REAL-TIME MULTIPROCESSOR SYSTEMS WITH SHARED ACCELERATORS

**Presenter:**
Marco Bekooij, University of Twente, NL

**Authors:**
Guus Kuiper, Stefan Geuns, Philip Wilmanns, Joost Haunsma and Marco Bekooij, University of Twente, NL

**Abstract**
Accelerators are added in real-time multiprocessor systems for power-efficiency improvement and cost reduction. Sharing of these accelerators improves their utilization but without tool support it also complicates programming. This demonstration shows a multiprocessor compiler for a real-time multiprocessor system that contains support for the sharing of hardware accelerators. The capabilities of this compiler are demonstrated by mapping a packet based GMSK receiver application onto this multiprocessor system. The multiprocessor system is implemented on an Xilinx Virtex-6 FPGA to which an RF front-end is connected. This multiprocessor system contains 16 Microblaze processors and 5 accelerators. With this system a real-time digital audio stream is received and demodulated.

**More information ...**

UB06.5 THE Ψ-CHART DESIGN APPROACH IN TTOOL/DIPLODOCUS: A FRAMEWORK FOR HW/SW CO-DESIGN OF DATA-DOMINATED SYSTEMS-ON-CHIP

**Presenter:**
Andrea Enrici, Télécom ParisTech, FR

**Authors:**
Ludovic Aprville, Daniel Camara and Renaud Pacalet, Télécom ParisTech, FR

**Abstract**
In the scope of the DATE 2015 University Booth, we present our latest achievements for the system level design of parallel and distributed embedded systems. We propose a demonstration of a novel design approach, the Ψ-chart, in TTool/Diplodocus, a UML/SysML framework for the design, validation and automatic code generation for data-dominated SoCs. The Ψ-chart is a design approach where communication patterns are designed with dedicated models, independently of a pair application-architecture, before mapping phase. It allows for a complete orthogonalization of concerns between the design of computations and communications, thus achieving faster Design Space Exploration, complete design portability as well as reduced design times and costs. The subject of our demonstration is the design of the physical layer (PHY) of the transmitter part of the ZigBee wireless standard (IEEE 802.15.4) mapped onto a MPSoC architecture with shared memory. Our demonstration will illustrate the full design of the ZigBee transmitter, from models to the automatic generation of the emulation code, via simulation and formal verification. We will validate our design by comparing the output samples produced by the emulation code, with a real implementation of the transmitter on a FPGA prototyping board.

**More information ...**

UB06.6 INTERACTIVE VISUALIZATION OF ESL DESIGNS

**Presenter:**
Jannis Stoppe, University of Bremen, DE

**Authors:**
Robert Wille and Rolf Drechsler, University of Bremen/DFKI GmbH, DE

**Abstract**
In this work, we propose an improved visualization tool for SystemC which assists a designer in communicating a system’s structure and behavior. Please see the uploaded pdf-file for details.

**More information ...**

UB06.7 AN FPGA LAB-ON-CHIP: AN ANALYSIS TOOL AND FRAMEWORK FOR ADVANCED MEASUREMENTS AND RELIABILITY ASSESSMENTS ON MODERN NANOSCALE FPGAS

**Presenter:**
Petr Pfeifer, Technical University of Liberec, CZ

**Abstract**
Wide portfolio of new technologies in design and manufacturing of advanced integrated circuits enables higher integration of complex structures at ultra-high nanoscale densities, but also sensitivity to various changes of the internal nanostructures and their parameters, resulting in the requirement of advanced reliability assessments. The developed and presented revolutionary new set of tools enables complex lab-on-chip solutions in nanoscale FPGAs and it allows easy implementation of tasks like completely on-chip internal parameter measurements in FPGAs, actual structure delays with respect to environmental parameters, device and platform identification, validation of selected design parameters, identification of crosstalk path and mutual impacts, as well as various changes in internal parameters. It actively supports design reconfiguration. The set of tools can be used for fast standalone or system built-in post-production device and platform parameter and quality checking and validation, parameter-aware placement and routing of critical design parts and performance optimization of existing designs, device aging identification and measurement, active and online data generation for reliability assessments and design reliability enhancements. It is available for FPGAs from 90nm down and will be demonstrated on advanced 28nm Xilinx FPGAs.

**More information ...**

UB06.8 MAMMA: SPEECH ENHANCEMENT DEMO EXPLOITING MEMS MICROPHONE ARRAY FOR PEOPLE WITH DISABILITIES

**Presenter:**
Luca Sarti, University of Pisa, IT

**Authors:**
Alessandro Palla1, Luca Fanucci1 and Roberto Sannino2  
1University of Pisa, IT; 2STMicroelectronics, IT

**Abstract**
Disabled people, especially the ones with motor skill impairments, have difficulties in interaction with electronic devices. Indeed voice recognition could be exploited, but its performance strongly depends by the environmental noise. We propose a wearable speech enhancement system based on MEMS microphone array and an ARM Cortex M4 CPU featuring a beamforming technique and an adaptive acoustic echo cancellation filtering in order to increase SNR of acquired voice stream. An increase by 16.5 dB in the SNR is obtained when noise and voice come from opposite directions. Theoretical analysis and in-system measurements prove the effectiveness of the proposed solution.

**More information ...**

UB06.9 AIDASOFT: ANALOG IC DESIGN AUTOMATION

**Presenter:**
Nuno Horta, Instituto de Telecomunicações/Instituto Superior Técnico, PT

**Authors:**
Nuno Lourenço1, Ricardo Martins1, Ricardo Póvoa1, António Canelas1, Ricardo Lourenço2 and Pedro Ventura2  
1Instituto de Telecomunicações/Instituto Superior Técnico, PT; 2Instituto de Telecomunicações, PT

**Abstract**
This demo presents AIDA an ongoing project at Instituto de Telecomunicações/University of Lisbon, Portugal, which addresses analog IC design automation from circuit-level specifications to layout descriptions in GDS-II. AIDA consists of two main modules AIDA-C and AIDA-L. AIDA-C is demonstrated for layout-aware circuit-level sizing and optimization by generating a family of robust Pareto Optimal solutions. AIDA-L is demonstrated by generating the layout taking into account electrical currents information to mitigate electromigration and IR-drop effects, and also wiring symmetry for multiport multi-terminal signal nets of analog ICs.

**More information ...**

14:00 End of session
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**Lunch Break**

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Coffee Break 16:00 - 17:00

**Wednesday, March 11, 2015**

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)

Coffee Break 16:00 - 17:00

**Thursday, March 12, 2015**

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00

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### 7.0 SPECIAL DAY Keynotes

**Date:** Wednesday 11 March 2015  
**Time:** 12:50 - 14:30  
**Location / Room:** Salle Oisans

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<tr>
<td>12:50</td>
<td>7.0.1</td>
<td>SPECIAL DAY KEYNOTE: INDUSTRIE 4.0: FROM THE INTERNET OF THINGS TO CYBER-PHYSICAL PRODUCTION SYSTEMS</td>
<td>Wolfgang Wahlster, German Research Center for Artificial Intelligence (DFKI), DE</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Abstract</strong></td>
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<td>The Internet of Things is finding its way into production. Semantic machine-to-machine communication revolutionizes factories by decentralized control. Embedded digital product memories guide the flexible work piece flow through smart factories, so that low-volume, high-mix production is realized in a cost-efficient way. A new generation of industrial assistant systems using augmented reality and multimodal interaction will help factory workers to deal with the complexity of cyber-physical production. INDUSTRIE 4.0 is the German strategic initiative to take up a pioneering role in industrial IT that is currently revolutionizing the manufacturing engineering sector. Semantic product memories will play a key role in the upcoming fourth industrial revolution based on cyber-physical production systems. Low-cost and compact digital storage, sensors and radio modules make it possible to embed a digital memory into a product for recording all relevant events throughout the entire lifecycle of the artifact. By capturing and interpreting ambient conditions and user actions, such computationally enhanced products have a data shadow and are able to perceive and control their environment, to analyze their observations and to communicate with other smart objects and human users about their lifelog data. Cyber-physical systems and the Internet of Things lead to a disruptive change in the production architecture: the workpiece navigates through a highly instrumented smart factory and tries to find the production services that it needs in order to meet its individual product specifications stored on the product memory. We illustrate this revolutionary production architecture with examples from DFKI’s Smart Factory.</td>
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<td></td>
<td><strong>Abstract</strong></td>
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<td>On April 19th, 2015, we will celebrate the 50th anniversary of Moore’s law. Process technology went from several microns to a few nanometers, transistors integration capabilities increased millions of times, and volume production grew from the few thousands of units in the early digital computer era to the several billions in the smartphone one. IoT is expected to bring volume production up by one, and perhaps even two orders of magnitude in the next decade. Today, IC volume growth has been anchored on smart phones. Smart everything (cars, homes, cities) may be the next killer application, which would fuel the volume growth. IoT devices and systems will certainly span the entire spectrum, from extremely advanced and complex to &quot;disposable&quot;. They will make metrics such as reliability and resilience, be as important as performance, power, and area. But in order for IoT to happen, our industry should dramatically improve its efficiency - all &quot;resources&quot; are scarce, and therefore precious. Flexibility - systems are heterogeneous by nature - and productivity - to deliver the best possible quality-of-results within the allotted turn-around-time - will be critical. As both process technology and system complexity increase, advanced EDA will be a key enabler. Advanced design implementation infrastructure, tools, flows, and methodologies will deliver a competitive advantage, and advanced IP sub-systems, consisting of hardware and software solutions will deliver complete, complex functions, ready for integration, greatly simplifying the IoT &quot;siliconization&quot;. These two components show the only viable path towards the trillion units many industry leaders are envisioning.</td>
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| 14:30 |       | End of session                                           |                           |
Coffee Break in Exhibition Area

On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area.

Lunch Break

On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Ecrins (for fully registered conference delegates only).

Tuesday, March 10, 2015
Coffee Break 10:30 - 11:30
Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
Coffee Break 16:00 - 17:00

Wednesday, March 11, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)
Coffee Break 16:00 - 17:00

Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

UB07 Session 7

Date: Wednesday 11 March 2015
Time: 14:00 - 16:00
Location / Room: University Booth, Booth 4, Exhibition Area

<table>
<thead>
<tr>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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<tbody>
<tr>
<td>UB07.1</td>
<td>SMART CELL DEVELOPMENT PLATFORM FOR EMBEDDED BATTERY MANAGEMENT</td>
<td>Swaminathan Narayanaswamy, TUM CREATE, SG; Matthias Kauer(^1), Sebastian Steinhorst(^1), Martin Lukasiewycz(^1) and Samarjit Chakraborty(^2); TUM CREATE, SG; (^2)TU Munich, DE</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>Embedded Battery Management (EBM) \cite{1}, in contrast to the existing state-of-the-art centralized Battery Management Systems (BMSs) found in Electric Vehicles (EVs) or stationary Electrical Energy Storage (EES) applications, focuses on monitoring and controlling each individual cell of the battery pack with a dedicated Cell Management Unit (CMU). This novel approach of battery management might offer significant advantages over the centralized BMSs, such as higher modularity, plug-and-play integration and shorter time to market. The combination of a battery cell and a CMU forms the smart cell and the system-level functionalities of the EBM are performed in a decentralized manner by the network of smart cells, with the help of the computational and communication resources of CMUs. We present a development platform for such a smart cell enabled EBM. The development platform consists of two components, the hardware platform and the software platform. The hardware platform of the demonstrator comprises of battery cells and their dedicated CMUs which consist of a smart cell controller board and an active cell balancing board. The software platform provides the smart cell firmware as well as a software tool for verification of active cell balancing architectures and a smart cell simulator for simulating system-level EBM functionalities.</td>
</tr>
<tr>
<td>UB07.2</td>
<td>FLARE: A RECONFIGURATION AWARE FLOORPLANNER</td>
<td>Riccardo Cattaneo, Politecnico di Milano, IT; Marco Rabozzi and Marco Santambrogio, Politecnico di Milano, IT</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>This demonstration presents a floorplanner tool addressing partially-reconfigurable FPGAs. The input of the tool consists of a set of regions described in terms of their heterogeneous resource requirements together with the number of interconnections among regions and the target FPGA of the partial reconfiguration (PR) design. Once the input are specified, the floorplanner allow the designer to manually or automatically perform the floorplan of the regions.</td>
</tr>
<tr>
<td>UB07.3</td>
<td>RSOC FRAMEWORK: FRAMEWORK FOR RAPID PROTOTYPING OF APPLICATIONS ON RECONFIGURABLE SOCS</td>
<td>Korcek Pavol, Brno University of Technology, CZ; Jan Viktorin, Vlastimil Kosar and Jan Korenek, Brno University of Technology, CZ</td>
</tr>
<tr>
<td></td>
<td>Abstract</td>
<td>Recent chips with ARM based processors and FPGA logic provide potential for many applications. IP cores and operating systems (OS) have been prepared to simplify development. However the integration of IP cores and OS is not covered by any development tool yet. We propose universal Reconfigurable System on Chip (RSoC) Framework to support rapid prototyping of different applications on these chips. Application can run in FPGA and/or in processor and RSoC Framework covers all mutual communication.</td>
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More information...
**Abstract**
The Self-timed ring based True Random Number Generator (STRING) leverages the jitter of events propagating in a self-timed ring to generate provably random binary sequences. Several implementations in FPGAs and in CMOS design flows have shown the feasibility of this generator in digital technologies, and also confirmed that it can provide high quality random bit sequences that pass the standard statistical test batteries at rates as high as 200 Mbit/s. Following AIS31 recommendations for the design and evaluation of TRNGs, the security of this generator is based primarily on an entropy assessment obtained by modeling the entropy extraction and measuring the entropy source. Secondly, the generator is protected against active attacks by monitoring its behavior in real-time or on demand. In this demonstration, we illustrate this approach in an Altera Cyclone III implementation of the STRING. We show how the design is configured depending on the measurement of the entropy source (the jitter magnitude) in order to guarantee a given minimum entropy rate per output bit. Then, we emulate physical attacks on the generator by willingly manipulating its internal structure in order to demonstrate how the entropy monitoring can detect abnormal behaviors and send the appropriate alarms.

**More information ...**
Coffee Break in Exhibition Area

Coffee Break in Exhibition Area

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Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics

Coffee Break 16:00 - 17:00

Wednesday, March 11, 2015

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Thursday, March 12, 2015

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00

7.1 SPECIAL DAY Hot Topic: Design Tools for the IoT

Date: Wednesday 11 March 2015
Time: 14:30 - 16:00
Location / Room: Salle Oisans

Organisers:
Frank Schirrmeister, Cadence Design Systems, US
Rolf Drechsler, University of Bremen/DFKI GmbH, DE

Chair:
Frank Schirrmeister, Cadence Design Systems, US

This sessions will describe challenges and solutions regarding the development aspects of the internet of things. Based on user challenges described by NXP and Intel, ARM and Cadence will describe IP and tool offerings for development of Embedded Software as well as SoCs in edge node, gateway and cloud devices.

<table>
<thead>
<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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<tbody>
<tr>
<td>14:30</td>
<td>7.1.1</td>
<td>IOT CHALLENGES AND OPPORTUNITIES</td>
<td>Frank Schirrmeister, Cadence Design Systems, US</td>
</tr>
<tr>
<td>14:52</td>
<td>7.1.2</td>
<td>IOT DEVELOPMENT FOR A CONNECTED CAR</td>
<td>Marco Bekooij, NXP Semiconductors, NL</td>
</tr>
<tr>
<td>15:14</td>
<td>7.1.3</td>
<td>IF IT’S NOT ON THE INTERNET, IT’S JUST A THING: BUT WHAT ARE THE IOT PROBLEMS TO SOLVE?</td>
<td>Remy Pottier, ARM, FR</td>
</tr>
<tr>
<td>15:36</td>
<td>7.1.4</td>
<td>IOT HARDWARE &amp; MIXED SIGNAL DEVELOPMENT</td>
<td>Ian Dennison, Cadence Design Systems, GB</td>
</tr>
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</table>
Coffee Break in Exhibition Area

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**Thursday, March 12, 2015**

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00

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7.2 Hot Topic - Trading Accuracy for Efficient Computing

**Date:** Wednesday 11 March 2015  
**Time:** 14:30 - 16:00  
**Location / Room:** Belle Etoile

**Organisers:**  
Anand Raghunathan, Purdue University, US  
Akash Kumar, National University of Singapore, SG  

**Chair:** Muhammad Shafique, Karlsruhe Institute of Technology, DE  
**Co-Chair:** Marc Geilen, Eindhoven University of Technology, NL

This session will introduce inexact or approximate computing, a promising direction to improve the efficiency of computing in the face of diminishing benefits from scaling. Speakers will discuss the key challenges in the field and provide a vision for bringing these technologies to the mainstream. The session will cover approximate hardware, system level inexactness, and memory models. An application of the design principles to weather simulation will also be presented.

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<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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</table>
| 14:30 | 7.2.1 | COMPUTING APPROXIMATELY, AND EFFICIENTLY | Swagath Venkataramani 1, Srimat T. Chakradhar 2, Kaushik Roy 1 and Anand Raghunathan 1  
1: Purdue University, US; 2: NEC Laboratories America, US |

**Abstract**  
Recent years have witnessed significant interest in the area of approximate computing. Much of this interest stems from the quest for new sources of computing efficiency in the face of diminishing benefits from technology scaling. We argue that trends in computing workloads will greatly increase the opportunities for approximate computing, describe the vision and key principles that have guided our work in this area, and outline a range of approximate computing techniques that we have developed at all layers of the computing stack, spanning circuits, architecture, and software.

Download Paper (PDF; Only available from the DATE venue WiFi)

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<th>Presentation Title</th>
<th>Authors</th>
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</table>
| 14:52 | 7.2.2 | NOVEL INEXACTNESS AWARE ALGORITHM CO-DESIGN FOR ENERGY EFFICIENT COMPUTATION | Guru Prakash Arumugam 1, Ayush Bhargava 1, Prashanth Srikanth 1, Sreelatha Yenugula 1, John Augustine 1, Eli Upfal 2, and Krishna Palem 3  
1: Indian Institute of Technology Madras, IN; 2: Brown University, US; 3: Rice University, US |

**Abstract**  
It is increasingly accepted that energy savings can be achieved by trading the accuracy of a computing system for energy gains—quite often significantly. This approach is referred to as inexact or approximate computing. Given that a significant portion of the energy in a modern general purpose processor is spent on moving data to and from storage, and that increasingly data movement contributes significantly to activity during the execution of applications, it is important to be able to develop techniques and methodologies for inexact computing in this context. To accomplish this to its fullest level, it is important to start with algorithmic specifications and alter their intrinsic design to take advantage of inexactness. This calls for a new approach to inexact memory aware algorithm design (IMAD) or co-design. In this paper, we provide the theoretical foundations which include novel models as well as technical results in the form of upper and lower bounds for IMAD in the context of universally understood and canonical problems: variations of sorting, and string matching. Surprisingly, IMAD allowed us to design entirely error-free algorithms while achieving energy gain factors of 1.5 and 5 in the context of sorting and string matching when compared to their traditional (textbook) algorithms. IMAD is also amenable to theoretical analysis and we present several asymptotic bounds on energy gains.

Download Paper (PDF; Only available from the DATE venue WiFi)
DESIGNING INEXACT SYSTEMS EFFICIENTLY USING ELIMINATION HEURISTICS

Speakers:
Shyamsundar Venkataraman¹, Akash Kumar¹, Jeremy Schlachter² and Christian Enz²
¹National University of Singapore, SG; ²École Polytechnique Fédérale de Lausanne (EPFL), CH

Abstract
There are a wide variety of applications that are able to tolerate small errors in the values of the outputs, provided they are within the application-specific thresholds. For such applications, there have been many efforts to study the trade-off involved in the accuracy of the output and the energy/area requirement. However, most of the efforts have been at the level of individual components. In this article, we present a design flow to study the inexactness at the level of system and provide heuristics to quickly explore the design-space under given inexactness and area/energy constraints. The approach is applied to various digital signal processing filters and an ECG application of QRS detection. In both cases, orders of magnitude speed-ups are obtained in the design-flow process.

Download Paper (PDF; Only available from the DATE venue WiFi)

OPPORTUNITIES FOR ENERGY EFFICIENT COMPUTING: A STUDY OF INEXACT GENERAL PURPOSE PROCESSORS FOR HIGH-PERFORMANCE AND BIG-DATA APPLICATIONS

Speakers:
Peter Duben¹, Jeremy Schlachter², - Parishkrati³, Sreelatha Yenugula¹, John Augustine³, Christian Enz², K. Palem⁴ and T. N. Palmer⁵
¹Oxford University, GB; ²École Polytechnique Fédérale de Lausanne (EPFL), CH; ³Indian Institute of Technology Madras, IN; ⁴Rice University, Houston, US; ⁵University of Oxford, GB

Abstract
In this paper, we demonstrate that disproportionate gains are possible through a simple devise for injecting inexactness or approximation into the hardware architecture of a computing system with a general purpose template including a complete memory hierarchy. The focus of the study is on energy savings possible through this approach in the context of large and challenging applications. We choose two such from different ends of the computing spectrum—the IGCM model for weather and climate modeling which embodies significant features of a high-performance computing workload, and the ubiquitous PageRank algorithm used in Internet search. In both cases, we are able to show in the affirmative that an inexact system outperforms its exact counterpart in terms of its efficiency quantified through the relative metric of operations per virtual Joule (OPVJ)—a relative metric that is not tied to particular hardware technology. As one example, the IGCM application can be used to achieve savings through inexactness of (almost) a factor of 3 in energy without compromising the quality of the forecast, quantified through the forecast error metric, in a noticeable manner. As another example finding, we show that in the case of PageRank, an inexact system is able to outperform its exact counterpart by close to a factor of 1.5 using the OPVJ metric.

Download Paper (PDF; Only available from the DATE venue WiFi)
14:30 7.3.1 INTRODUCTION TO HARDWARE TROJAN DETECTION METHODS
Speakers:
Julien Franci\textsuperscript{1} and Florian Frick\textsuperscript{2}
\textsuperscript{1}Cassidian, FR; \textsuperscript{2}University of Stuttgart, DE

Abstract
Hardware Trojans (HTs) are identified as an emerging threat for the integrity of Integrated Circuits (ICs) and their applications. Attackers attempt to maliciously manipulate the functionality of ICs by inserting HTs, potentially causing disastrous effects (Denial of Service, sensitive information leakage, etc.). Over the last 10 years, various methods have been proposed in literature to circumvent HTs. This article introduces the general context of HTs and summarizes the recent advances in HT detection from a French funded research project named HOMERE. Some of these results will be detailed in the related special session.

Download Paper (PDF; Only available from the DATE venue WiFi)

14:45 7.3.2 NEW TESTING PROCEDURE FOR FINDING INSERTION SITES OF STEALTHY HARDWARE TROJANS
Speakers:
Sophie Dupuis, Papa-Sidy Ba, Marie-Lise Flottes, Giorgio Di Natale and Bruno Rouzeyre, LIRMM, FR

Abstract
Hardware Trojans (HTs) are malicious alterations to a circuit. These modifications can be inserted either during the design phase or during the fabrication process. Due to the diversity of Hardware Trojans, detecting and/or locating them are challenging tasks. Numerous approaches have been proposed to address this problem. Methods based on logic testing consist in trying to activate potential HTs and detect erroneous outputs during test. However, HTs are stealthy in nature i.e. mostly inactive unless they are triggered by a very rare condition. The activation of a HT is therefore a major challenge. In this paper, we propose a new testing procedure dedicated to identifying where a possible HT may be easily inserted and generating the test patterns that are able to excite these sites. The selection of the sites is based on the assumption that the HT (i) is triggered by signals with low controllability, (ii) combines them using gates in close proximity in the circuit's layout, and (iii) without introducing new gates in critical paths.

Download Paper (PDF; Only available from the DATE venue WiFi)

15:00 7.3.3 HARDWARE TROJAN DETECTION BY DELAY AND ELECTROMAGNETIC MEASUREMENTS
Speakers:
X-T. Ngo\textsuperscript{1}, I Exurville\textsuperscript{2}, S Bhasin\textsuperscript{1}, Jean-Luc Danger\textsuperscript{1}, Sylvain Guille\textsuperscript{1}, Z Najm\textsuperscript{1}, Jean Baptiste Rigaud\textsuperscript{1} and Bruno Robinsson\textsuperscript{2}
\textsuperscript{1}Télécom ParisTech, FR; \textsuperscript{2}CEA, FR; \textsuperscript{3}REMSE, FR

Abstract
Hardware trojan (HT) inserted in integrated circuits have received special attention of researchers. In this paper, we present firstly a novel HT detection technique based on path delays measurements. A delay model is established for a net, which consider intra-die process variations. Secondly, we show how to detect HT using Electromagnetic (EM) measurements. We study the HT detection probability according to its size taking into account the inter-die process variations with a set of FPGAs. The results show that: there is a probability superior than 95% with a false negative rate of 5% to detect a HT bigger than 1.7% of the original circuit.

Download Paper (PDF; Only available from the DATE venue WiFi)

15:30 7.3.4 A HIGH EFFICIENCY HARDWARE TROJAN DETECTION TECHNIQUE BASED ON FAST SEM IMAGING
Speakers:
Franck Courbon\textsuperscript{1}, Philippe Loubet-Moundi\textsuperscript{2}, Fournier Jacques\textsuperscript{3} and Assia Tria\textsuperscript{3}
\textsuperscript{1}GEMALTO Security Labs/Ecole des Mines de Saint-Etienne, FR; \textsuperscript{2}Gemalto, FR; \textsuperscript{3}CEA Tech Region DPACA/LSAS, FR

Abstract
In the semiconductor market where more and more companies become fabless, malicious integrated circuits' modifications are seen as possible threats. Those Hardware Trojans can have various effects and can be implemented by different entities with different means. This article includes the integration of an almost automatic Hardware Trojan detection. The latter is based on a visual inspection implemented within the integrated circuit life cycle. The proposed detection methodology is quite efficient regarding tools, user experience and time needed. A single layer of the chip is accessed and then imaged with a Scanning Electron Microscope (SEM). The acquisition of several hundred images at high magnification is automated as does the images registration. Then depending on the reference availability, one can check if any supplementary gates have been inserted in the design using a golden reference or a graphic/text design file. Downloading the reference, either basic image processing is used to compare the chip extracted image with a golden model or some pattern recognition can be used to retrieve the number of occurrences of each standard cell. The depicted methodology aims to detect any gate modification, substitution, removal or addition and so far require an invasive approach and a reference.

Download Paper (PDF; Only available from the DATE venue WiFi)

16:00 End of session
Coffee Break in Exhibition Area
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Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00
NoCs are migrating into large-scale multicore systems which lead to new issues to be solved. In this session, we see how NoCs can tackle both faulty behaviors and performance bottlenecks. The first paper demonstrates low overhead multicast using surface-wave communication. The two other papers deal with low-overhead and low-latency fault-tolerance.

**Abstract**

**MIXED WIRE AND SURFACE-WAVE COMMUNICATION FABRICS FOR DECENTRALIZED ON-CHIP MULTICASTING**

*Speakers:*

Ammar Karkar,1, Kin-Fai Tong,1, Terrence Mak1 and Alex Yakovlev1

1School of Electrical and Electronic Engineering, Newcastle University, Newcastle upon Tyne, GB; 2Department of Electrical and Electronic Engineering, UCL, London, GB; 3Department of Computer Science and Engineering, The Chinese University of Hong Kong, Hong Kong, CN

**Abstract**

Network-on-chip (NoC) has emerged to tackle different on-chip challenges and has satisfied different demands in terms of high performance, economical and reliable interconnect implementation. However, a merely metal-based interconnect reaches performance bound with the relentless technology scaling. Especially, it displayed a bottleneck to meet the communication bandwidth demand for multicasting. This paper proposes a novel hybrid architecture, which improves the on-chip communication bandwidth significantly using mixed wires and surface wave interconnects (SWI) fabrics. In particular, the bandwidth of multicasting can be drastically improved. We introduce a decentralized arbitration method to fully utilize the slack-time scheduling with deadlock-free flow control. Evaluation results, based on a cycle-accurate and hardware-based simulation, demonstrate the effectiveness of the proposed architecture and methods. Compared to a wire-based NoC, the mixed fabric approach can achieve an improvement in power reduction and communication speed up to 63% and 12X, respectively. These results are achieved with almost negligible hardware overheads. This new paradigm efficiently addresses the emerged challenges for on-chip communications.

Download Paper (PDF; Only available from the DATE venue WiFi)

**D2-LBDR: DISTANCE-DRIVEN ROUTING TO HANDLE PERMANENT FAILURES IN 2D MESH NOCS**

*Speakers:*

Rimpy Bisnhoi,1, Manoj Gaur1, Vijay laxmi1 and Josè Flich2

1Malaviya National Institute of Technology, IN; 2Associate Professor, Universitat Politècnica de Valencia, ES

**Abstract**

With the advent of deep sub-micron technology, fault-tolerant solutions are needed to keep many-core chips operative. In NoCs, Logic Based Distributed Routing (LBDR) proved to be a flexible routing framework for 2D meshes with link and router faults. However, to provide full coverage, LBDR requires a module named FORKS which replicates some messages. This imposes the use of virtual cut-through switching and a complex router arbiter, increasing excessively the router cost, mainly in buffer area. Also, some failure combinations require the use of a non-trivial dynamic reconfiguration strategy to avoid deadlocks. We propose d2 -LBDR which adds, on every router, a distance register to the closest failure. This enables the support of more failure combinations without an excessive implementation cost. Indeed, we restore the use of wormhole switching, keeping router architecture simple, while achieving the same fault coverage as the best LBDR version, without requiring complex switching strategies nor any dynamic reconfiguration strategy. Results show that a small area overhead (3%) is enough for the implementation of a fully flexible routing method without any limiting support case when compared with LBDR. d2 -LBDR reduces area overhead over the best LBDR approach (300% overhead against 3%) while preserving fault coverage. Results show d2 -LBDR performance equal to LBDR.

Download Paper (PDF; Only available from the DATE venue WiFi)

**SYNERGISTIC USE OF MULTIPLE ON-CHIP NETWORKS FOR ULTRA-LOW LATENCY AND SCALABLE DISTRIBUTED ROUTING RECONFIGURATION**

*Speakers:*

Marco Balboni1, José Flich2 and Davide Bertozzi1

1University of Ferrara, IT; 2Associate Professor, Universitat Politècnica de València, ES

**Abstract**

With the advent of deep sub-micron technology, fault-tolerant solutions are needed to keep many-core chips operative. In NoCs, Logic Based Distributed Routing (LBDR) proved to be a flexible routing framework for 2D meshes with link and router faults. However, to provide full coverage, LBDR requires a module named FORKS which replicates some messages. This imposes the use of virtual cut-through switching and a complex router arbiter, increasing excessively the router cost, mainly in buffer area. Also, some failure combinations require the use of a non-trivial dynamic reconfiguration strategy to avoid deadlocks. We propose d2 -LBDR which adds, on every router, a distance register to the closest failure. This enables the support of more failure combinations without an excessive implementation cost. Indeed, we restore the use of wormhole switching, keeping router architecture simple, while achieving the same fault coverage as the best LBDR version, without requiring complex switching strategies nor any dynamic reconfiguration strategy. Results show that a small area overhead (3%) is enough for the implementation of a fully flexible routing method without any limiting support case when compared with LBDR. d2 -LBDR reduces area overhead over the best LBDR approach (300% overhead against 3%) while preserving fault coverage. Results show d2 -LBDR performance equal to LBDR.

Download Paper (PDF; Only available from the DATE venue WiFi)

**A HYBRID PACKET/CIRCUIT-SWITCHED ROUTER TO ACCELERATE MEMORY ACCESS IN NOC-BASED CHIP MULTIPROCESSORS**

*Speakers:*

Yassin Mazloumi and Mehdi Modarressi, University of Tehran, IR

**Abstract**

Modern chip multiprocessors will feature a large shared last-level cache (LLC) that is decomposed into smaller slices and physically distributed throughout the chip area. These architectures rely on a network-on-chip (NoC) to handle remote cache access and hence, NoCs play a critical role in optimizing memory access latency and power consumption. Circuit-switching is the most power- and performance-efficient switching mechanism in NoCs, but is not advantageous when the packet transmission time is not long enough compared to the circuit setup time. In this paper, we propose a zero-latency circuit setup scheme to make circuit-switching applicable in transferring individual data packets. The design leverages the fact that in CMPs with distributed LLC (where a considerable portion of the on-chip traffic is composed of remote LLC access requests and data responses), every response packet is sent in reply to a request packet and traverses the same path as its corresponding request, but at the backward direction. The short request packets, then, are responsible to reserve a path for their corresponding response packets. This NoC tries to reduce conflict among circuit paths by considering conflicts in backward direction during request packet routing, backed by a run-time technique to resolve conflicts when circuits are actually set up. Experimental results show that the proposed NoC architecture considerably reduces average packet latency that directly translates to faster memory access.

Download Paper (PDF; Only available from the DATE venue WiFi)
Coffee Break in Exhibition Area

On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area.

Lunch Break

On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Ecrins (for fully registered conference delegates only).

Tuesday, March 10, 2015
Coffee Break 10:30 - 11:30
Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
Coffee Break 16:00 - 17:00

Wednesday, March 11, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)
Coffee Break 16:00 - 17:00

Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

7.5 System Reliability: from Runtime to Design Languages

Date: Wednesday 11 March 2015
Time: 14:30 - 16:00
Location / Room: Meije
Chair: Dirk Stroobandt, Ghent University, BE
Co-Chair: Diana Goehringer, University of Bochum, DE

Over the last few years, reliability has become an increasingly relevant consideration for electronic systems. This session will address system reliability from design flow to run-time in both digital as well as analog systems.

<table>
<thead>
<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>14:30</td>
<td>7.5.1</td>
<td>AXILOG: LANGUAGE SUPPORT FOR APPROXIMATE HARDWARE DESIGN</td>
<td>Amir Yazdanbakhsh¹, Divya Mahajan¹, Bradley Thwaites¹, Jongse Park¹, Anandhavel Nagendrakumar¹, Sindhuja Sethuraman¹, Kartik Ramkrishnan², Nishanthi Ravindran³, Rudra Jariwala³, Abbas Rahimi³, Hadi Esmalizadeh¹ and Kia Bazargan²</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Speakers:</td>
<td>Georgia Institute of Technology, US; ¹University of Minnesota, US; ²University of San Diego, US</td>
</tr>
</tbody>
</table>

Abstract
Relaxing the traditional abstraction of “near-perfect” accuracy in hardware design can lead to significant gains in energy efficiency, area, and performance. To exploit this opportunity, there is a need for design abstractions that can systematically incorporate approximation in hardware design. We introduce Axilog, a set of language annotations, that provides the necessary syntax and semantics for approximate hardware design and reuse in Verilog. Axilog enables the designer to relax the accuracy requirements in certain parts of the design, while keeping the critical parts strictly precise. Finally, the paper describes a synthesis flow that approximates only the relaxable elements. Axilog enables applying approximation in the synthesis process while abstracting away the details of approximate synthesis from the designer. We evaluate Axilog, its analysis, and the synthesis flow using a diverse set of benchmark designs. The results show that the intuitive nature of the language extensions coupled with the automated analysis enables safe approximation of designs even with thousands of lines of code. Applying our approximate synthesis flow to these designs yields, on average, 54% energy savings and 1.9× area reduction with 10% output quality loss.

Download Paper (PDF; Only available from the DATE venue WiFi)
THERMAL-AWARE FLOORPLANNING FOR PARTIALLY-RECONFIGURABLE FPGA-BASED SYSTEMS

Davide Pagano, Mikel Vuka, Marco Rabozzi, Riccardo Cattaneo, Donatella Sciuto and Marco D. Santambrogio, Politecnico di Milano, IT

Abstract

Field Programmable Gate Arrays (FPGAs) systems are being more and more frequent in high performance applications. Temperature affects both reliability and performance, therefore its optimization has become challenging for system designers. In this work we present a novel thermal aware floorplanner based on both Simulated Annealing (SA) and Mixed-Integer Linear Programming (MILP). The proposed method takes into account an accurate description of heterogeneous resources and partially reconfigurable constraints of recent FPGAs. Our major contribution is to provide a high level formulation for the problem, without resorting to low level consideration about FPGAs resources. Within our approach we combine the benefits of SA and MILP to handle both linear and non-linear optimization metrics while providing an effective exploration of the solution space. Experimental results show that, for several designs, it is possible to reduce the peak temperature by taking into account power consumption during the floorplanning stage.

Download Paper (PDF; Only available from the DATE venue WiFi)
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Thursday, March 12, 2015

Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

7.6 Test Power and 3-D Fault Tolerance

Date: Wednesday 11 March 2015
Time: 14:30 - 16:00
Location / Room: Bayard
Chair: Juergen Schloeffel, Mentor, DE
Co-Chair: Sybille Hellebrand, Universität Paderborn, DE

The section presents low power solutions for scan-based test and a new redundant TSV architecture for 3-D ICs

<table>
<thead>
<tr>
<th>Time</th>
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<th>Presentation Title</th>
<th>Authors</th>
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<tbody>
<tr>
<td>14:30</td>
<td>7.6.1</td>
<td>DP-FILL : A DYNAMIC PROGRAMMING APPROACH TO X-FILLING FOR MINIMIZING PEAK TEST POWER IN SCAN TESTS</td>
<td>Satya A. Trinadh1, Sobhan Babu Ch.1, Shiv Govind Singh1, Seetal Potluri2 and Kamakoti V2</td>
</tr>
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<td></td>
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<td>1Indian Institute of Technology Hyderabad, IN; 2Indian Institute of Technology Madras, IN</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abstract</td>
<td>At-speed testing is crucial to catch small delay defects that occur during the manufacture of high performance digital chips. Launch-Off-Capture (LOC) and Launch-Off-Shift (LOS) are two prevalently used schemes for this purpose. LOS scheme achieves higher fault coverage while consuming lesser test time over LOC scheme, but dissipates higher power during the capture phase of the at-speed test. Excessive IR-drop during capture phase on the power grid causes false delay failures leading to significant yield reduction that is unarranted. As reported in literature, an intelligent filling of don't care bits (X-filling) in test cubes has yielded significant power reduction. Given that the tests output by ATPG tools for big circuits have large number of don't care bits, the X-filling technique is very effective for them. Assuming that the DFT preserves the state of the combinational logic between capture phases of successive patterns, this paper maps the problem of optimal X-filling for peak power minimization during LOS scheme to a variant of interval coloring problem and proposes a dynamic programming (DP) algorithm for the same along with a theoretical proof for its optimality. The proposed algorithm when experimented on ITC99 benchmarks produced peak power savings of up to 34% over the best known low power X-filling algorithm for LOS testing. Interestingly, it is observed that the power savings increase with the size of the circuit.</td>
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<td>15:00</td>
<td>7.6.2</td>
<td>A SCAN PARTITIONING ALGORITHM FOR REDUCING CAPTURE POWER OF DELAY-FAULT LBIST</td>
<td>Nan Li1, Elene Dubrova2 and Gunnar Carlsson3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Speakers:</td>
<td>1Royal Institute of Technology, SE; 2Ericsson AB/Royal Institute of Technology - KTH, SE; 3Development Unit Radio, Ericsson AB, SE</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abstract</td>
<td>It is well-known that high power consumption in test mode can cause problems such as overheating and JR-drop which have negative effect on circuit reliability and yield. The problem is particularly hard in the case of at-speed delay-fault testing where it cannot be mitigated by lowering the clock frequency. The difficulty increases even further if pseudo-random rather than ATPG patterns are used for testing. ATPG patterns can be chosen selectively, as well as re-ordered and specified in a power-friendly manner. This is not possible with pseudo-random test patterns. In this paper, we present a scan partitioning algorithm for reducing capture power targeting delay-fault LBIST. The algorithm uses a novel weighted S-graph model in which the weights are determined by signal probability analysis. Our experimental results show that, on average, the presented method reduces average capture power by 50% and peak capture power by 39% with less than 2% loss in the transition fault coverage.</td>
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<td>Download Paper (PDF; Only available from the DATE venue WiFi)</td>
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</table>
ARCHITECTURE OF RING-BASED REDUNDANT TSV FOR CLUSTERED FAULTS

Speakers: Wei-Hen Lo, Kang Chi and TingTing Hwang, National Tsing Hua University, TW

Abstract
Three-dimensional Integrated Circuits (3D-ICs) that employ the Through-Silicon Vias (TSVs) vertically stacking multiple dies provide many benefits, such as high density, high bandwidth, low-power. However, the fabrication and bonding of TSVs may fail because of many factors, such as the winding level of the thinned wafers, the surface roughness and cleanliness of silicon dies, and bonding technology. To improve the yield of 3D-ICs, many redundant TSV architectures were proposed to repair 3D-ICs with faulty TSVs. These methods reroute signals of faulty TSVs to other regular or redundant TSVs. In practice, the faulty TSVs may cluster because of imperfect bonding technology. To resolve the problem of clustered TSV faults, router-based [1] redundant TSV architecture was the first paper proposed to pay attention to this clustering problem. Their method enables faulty TSVs to be repaired by redundant TSVs that are farther apart. However, for some rarely occurring defective patterns, their method consumes too much area. In this paper, we propose a ring-based redundant TSV architecture to utilize the area more efficiently as well as to maintain high yield. Simulation results show that for a given number of TSVs (8×8) and TSV failure rate (1%), our design achieves 55% area reduction of MUXes per signal, while the yield of our ring-based redundant TSV architectures can still maintain 98.47% to 99.00% as compared with router-based design [1]. Furthermore, the minimum shifting length of our ring-based redundant TSV architecture is at most 1 which guarantees the minimum timing overhead of each signal.

FEEDBACK-BUS OSCILLATION RING: A GENERAL ARCHITECTURE FOR DELAY CHARACTERIZATION AND TEST OF INTERCONNECTS

Speakers: Shi-Yu Huang, Meng-Ting Tsai, Kun-Han Tsai and Wu-Tung Cheng
National Tsing Hua University, TW; Mentor, US

Abstract
In this paper we propose a flexible delay characterization and test method for arbitrary die-to-die interconnects in a 3D IC. As compared to previous works, it is unique in its ability to streamline the characterization/test operations for a set of arbitrary interconnects with multiple pins sprawled multiple dies. During the Design-for-Testability stage, one common feedback-bus (connected to all dies in the IC under characterization/test) is inserted. Through the feedback-bus, a oscillation ring can be formed dynamically and the Variable-Output-Threshold (VOT) technique can be applied to characterize the delay of a selected interconnect segment at a time. Experimental results indicate that this method is not only flexible and scalable, but requiring only a small area overhead.

Energy-efficient Computing

Date: Wednesday 11 March 2015
Location / Room: Les Bans
Chair: Damien Querlioz, CNRS-IEF, FR
Co-Chair: Swaroop Ghosh, University of South Florida, US

The papers in this session are all focused on energy efficient computing. In the first talk, the authors present approaches for accelerating learning algorithms for resistive cross-point arrays. The next paper considers what training schemes are most suitable when RRAM arrays are used to realize spiking neural networks. Finally, the last presentation will discuss how devices that offer the potential for non-volatile state retention can be employed in power gating architectures.
16:00 7.7.3 COMPARATIVE STUDY OF POWER-GATING ARCHITECTURES FOR NONVOLATILE FINFET-SRAM USING SPINTRONICS-BASED RETENTION TECHNOLOGY

Speakers:
Yusuke Shuto
Tokyo Institute of Technology, JP; Tokyo Institute of Technology, JP

Abstract
Power-gating (PG) architectures employing nonvolatile state/data retention are expected to be a highly efficient energy reduction technique for high-performance CMOS logic systems. Recently, two types of PG architectures using nonvolatile retention have been proposed: One architecture is nonvolatile PG (NVPG) using nonvolatile bistable circuits such as nonvolatile SRAM (NV-SRAM) and nonvolatile flip-flop (NV-FF), in which nonvolatile retention is not utilized during the normal SRAM/FF operation mode and it is used only when there exist energetically meaningful shutdown periods given by break-even time (BET). In contrast, the other architecture employs nonvolatile retention during the normal SRAM/FF operation mode. In this type of architecture, an even shorter standby period can be replaced by a shutdown period, and thus this architecture is also called normally-off (NOF) rather than PG. In this paper, these two PG architectures for a FinFET-based high-performance NV-SRAM cell employing spintronics-based nonvolatile retention were systematically analyzed using HSPICE with a magnetoresistive-device macromodel. The NVPG architecture shows effective reduction of energy dissipation without performance degradation, whereas the NOF architecture causes severe performance degradation and the energy efficiency of the NOF architecture cannot be superior to that of the NVPG architecture.

Download Paper (PDF; Only available from the DATE venue WiFi)

16:01 7.7.2 SPIKING NEURAL NETWORK WITH RRAM: CAN WE USE IT FOR REAL-WORLD APPLICATION?

Speakers:
Yuhao Wang
1Tsinghua University, CN; 2University of Pittsburgh, US

Abstract
The spiking neural network (SNN) provides a promising solution to drastically promote the performance and efficiency of computing systems. Previous work of SNN mainly focused on increasing the scalability and level of realism in a neural simulation, while few of them support practical cognitive applications with acceptable performance. At the same time, based on the traditional CMOS technology, the efficiency of SNN systems is also unsatisfactory. In this work, we explore different training algorithms of SNN for real-world applications, and demonstrate that the Neural Sampling method is much more effective than Spiking Time Dependent Plasticity (STDP) and Remote Supervision Method (ReSuMe). We also propose an energy efficient implementation of SNN with the emerging metal-oxide resistive random access memory (RRAM) devices, which includes an RRAM crossbar array works as network synapses, an analog design of the spike neuron, and an input encoding scheme. A parameter mapping algorithm is also introduced to configure the RRAM-based SNN. Simulation results illustrate that the system achieves 91.2% accuracy on the MNIST dataset with an ultra-low power consumption of 3.5 mW. Moreover, the RRAM-based SNN system demonstrates great robustness to 20% process variation with less than 1% accuracy decrease, and can tolerate 20% signal fluctuation with about 2% accuracy loss. These results reveal that the RRAM-based SNN will be quite easy to be physically realized.

Download Paper (PDF; Only available from the DATE venue WiFi)

16:05 7.7.1 TECHNOLOGY-DESIGN CO-OPTIMIZATION OF RESISTIVE CROSS-POINT ARRAY FOR ACCELERATING LEARNING ALGORITHMS ON CHIP

Speakers:
Pai-Yu Chen, Deepak Kadetotad, Zihan Xu, Abinash Mohanty, Binbin Lin, Jieping Ye, Sarma Vrudhula, Jae-sun Seo, Yu Cao and Shimeng Yu
Arizona State University, US

Abstract
Technology-design co-optimization methodologies of the resistive cross-point array are proposed for implementing machine learning algorithms on a chip. A novel read and write scheme is designed to accelerate the training process, which realizes fully parallel operations of the weighted sum and the weight update. Furthermore, technology and design parameters of the cross-point array are co-optimized to enhance the array performance in learning tasks, including learning accuracy, latency and energy consumption. In contrast to the conventional memory design, a set of reverse scaling rules is proposed on the resistive cross-point array to achieve high learning accuracy. These include 1) larger wire width to reduce the IR drop on interconnects thereby increasing the learning accuracy; 2) use of multiple cells for each weight element to alleviate the impact of the device variations, at an affordable expense of area, energy and latency. The optimized resistive cross-point array with peripheral circuitry is implemented at the 65 nm node. Its performance is benchmarked for handwritten digit recognition on the MNIST database using gradient-based sparse coding. Compared to state-of-the-art software approach running on CPU, it achieves >1.5X speed-up and >1.6X energy efficiency improvement, enabling real-time image feature extraction and learning.

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7.8 Critical Research Areas Driven by Industry Transformations

Date: Wednesday 11 March 2015
Time: 14:30 - 16:00
Location / Room: Salle Lesdiguières

Organiser:
John Zhao, MathWorks, US

Moderator:
Pieter J. Mosterman, MathWorks, US

Panelists:
Koen Bertels, Delft University of Technology, NL
Axel Jantsch, Vienna University of Technology, AT
Ahmed Jerraya, CEA-Leti, FR
Ian O’Connor, Ecole Centrale de Lyon, FR
Joseph Sifakis, École polytechnique fédérale de Lausanne EPFL, CH

Increasing demands of electrification arise from connected vehicles, medical devices, smart-grid and microgrid technologies, and the IoT evolution of devices into smart, interconnected systems. Those systems must meet market requirements for not only more sophisticated functionality, but also improved performance and robustness. As a result, companies need to transform how they design, analyze, implement, and verify their systems. At the same time, embedded-system platforms have become increasingly diverse combinations of digital/analog electronics and software, ranging from FPGA/ARM platforms (e.g., Xilinx Zynq and Altera SoC) to a diverse range of heterogeneous manycore systems.

To help companies leverage these trends in their product and system development, EDA and embedded-system researchers are called upon to focus their research on new kinds of issues that arise. This panel will explore the key research needs and opportunities that come from the transformations that industries must embrace.

14:30  7.8.1  PANEL PRESENTATIONS AND DISCUSSIONS, WITH Q&A
A HARDWARE IMPLEMENTATION OF A RADIAL BASIS FUNCTION NEURAL NETWORK USING STOCHASTIC LOGIC

Speakers:
Yucan Ji, Feng Ran, Cong Ma and David Lilja
1 Shanghai University, CN; 2University of Minnesota - Twin Cities, US

Abstract
Hardware implementations of artificial neural networks typically require significant amounts of hardware resources. This paper proposes a novel radial basis function artificial neural network using stochastic computing elements, which greatly reduces the required hardware. The Gaussian function used for the radial basis function is implemented with a two-dimensional finite state machine. The norm between the input data and the center point is optimized using simple logic gates. Results from two pattern recognition case studies, the standard Iris flower and the MICR font benchmarks, show that the difference of the average mean squared error between the proposed stochastic network and the corresponding traditional deterministic network is only 1.3% when the stochastic stream length is 10kbits. The accuracy of the recognition rate varies depending on the stream length, which gives the designer tremendous flexibility to tradeoff speed, power, and accuracy. From the FPGA implementation results, the hardware resource requirement of the proposed stochastic hidden neuron is only a few percent of the hardware requirement of the conventional deterministic hidden neuron. The proposed stochastic network can be expanded to larger scale networks for complex tasks with simple hardware architectures.

Download Paper (PDF; Only available from the DATE venue WiFi)
Abstract

FPGA has been an emerging field in novel big data architectures and systems, due to its high efficiency and low power consumption. It enables the researchers to deploy massive accelerators within one single chip. In this paper, we present a software defined FPGA based accelerators for big data, named SODA, which could reconstruct and reorganize the accelerator engines according to the requirement of the various data-intensive applications. SODA decomposes large and complex applications into coarse grained single-purpose RTL code libraries that perform specialized tasks in out-of-order hardware. We built a prototyping system with constrained shortest path Finding (CSPF) case studies to evaluate SODA framework. SODA is able to achieve up to 43.75X speedup at 128 node application. Furthermore, hardware cost of the SODA framework demonstrates that it can achieve high speedup with moderate hardware utilization.

Download Paper (PDF; Only available from the DATE venue WiFi)
IP3-10  
A HYBRID PACKET/CIRCUIT-SWITCHED ROUTER TO ACCELERATE MEMORY ACCESS IN NOC-BASED CHIP MULTIPROCESSORS  
Speakers:  
Yassin Mazloumi and Mehdi Modarressi, University of Tehran, IR  
Abstract  
Modern chip multiprocessors will feature a large shared last-level cache (LLC) that is decomposed into smaller slices and physically distributed throughout the chip area. These architectures rely on a network-on-chip (NoC) to handle remote cache access and hence, NoCs play a critical role in optimizing memory access latency and power consumption. Circuit-switching is the most power- and performance-efficient switching mechanism in NoCs, but is not advantageous when the packet transmission time is not long enough compared to the circuit setup time. In this paper, we propose a zero-latency circuit setup scheme to make circuit-switching applicable in transferring individual data packets. The design leverages the fact that in CMPs with distributed LLC (where a considerable portion of the on-chip traffic is composed of remote LLC access requests and data responses), every response packet is sent in reply to a request packet and traverses the same path as its corresponding request, but at the backward direction. The short request packets, then, are responsible to reserve a path for their corresponding response packets. This NoC tries to reduce conflict among circuit paths by considering conflicts in backward direction during request packet routing, backed by a run-time technique to resolve conflicts when circuits are actually set up. Experimental results show that the proposed NoC architecture considerably reduces average packet latency that directly translates to faster memory access.  
Download Paper (PDF; Only available from the DATE venue WiFi)  

IP3-11  
SEMAUTOMATIC IMPLEMENTATION OF A BIOINSPIRED RELIABLE ANALOG TASK DISTRIBUTION ARCHITECTURE FOR MULTIPLE ANALOG CORES  
Speakers:  
Julius von Rosen 1, Markus Meissner 1 and Lars Hedrich 2  
1Goethe Universität Frankfurt, DE; 2Goethe-Universität Frankfurt a. M., DE  
Abstract  
In this paper we present a silicon implementation of a bioinspired analog task distribution system for enabling reliable analog multi-core systems. The increase in reliability is achieved by a dependable task distribution architecture using a hormone based mechanism. The specifications are generated by a feasibility analysis of the algebraic description of the architecture. Starting from the specifications, an automated analog synthesis framework is used to fasten the time-consuming design of the needed analog amplifiers. The complete system with the designed amplifiers has been layouted and fabricated. We present measurements of two different architectures of task distribution system on silicon showing the full functionality of the system and the design methodology.  
Download Paper (PDF; Only available from the DATE venue WiFi)  

IP3-12  
POWER-EFFICIENT ACCELERATOR ALLOCATION IN ADAPTIVE DARK SILICON MANY-CORE SYSTEMS  
Speakers:  
Muhammad Usman Karim Khan, Muhammad Shafique and Joerg Henkel, Karlsruhe Institute of Technology (KIT), DE  
Abstract  
Modern many-core systems in the dark silicon era face the predicament of underutilized resources of the chip due to power constraints. Therefore, hardware accelerators are becoming popular as they can overcome this problem by exercising a part of the program on dedicated custom logic in an energy efficient way. However, efficient accelerator usage poses numerous challenges, like adaptations for accelerator’s sharing schedule on the many-core systems under run-time varying scenarios. In this work, we propose a power-efficient accelerator allocation scheme for adaptive many-core systems that maximally utilizes and dynamically allocates a shared accelerator to competing cores, such that deadlines of the executing applications are met and the total power consumption of the overall system is minimized. The experimental results demonstrate power minimization and high accelerator utilization for a many-core system.  
Download Paper (PDF; Only available from the DATE venue WiFi)  

IP3-13  
THERMAL-AWARE FLOORPLANNING FOR PARTIALLY-RECONFIGURABLE FPGA-BASED SYSTEMS  
Speakers:  
Davide Pagano, Mikel Vuka, Marco Rabozzi, Riccardo Cattaneo, Donatale Sciuto and Marco D. Santambrogio, Politecnico di Milano, IT  
Abstract  
Field Programmable Gate Arrays (FPGAs) systems are being more and more frequent in high performance applications. Temperature affects both reliability and performance, therefore its optimization has become challenging for system designers. In this work we present a novel thermal aware floorplanner based on both Simulated Annealing (SA) and Mixed-Integer Linear Programming (MILP). The proposed method takes into account an accurate description of heterogeneous resources and partially reconfigurable constraints of recent FPGAs. Our major contribution is to provide a high level formulation for the problem, without resorting to low level consideration about FPGAs resources. Within our approach we combine the benefits of SA and MILP to handle both linear and non-linear optimization metrics while providing an effective exploration of the solution space. Experimental results show that, for several designs, it is possible to reduce the peak temperature by taking into account power consumption during the floorplanning stage.  
Download Paper (PDF; Only available from the DATE venue WiFi)  

IP3-14  
FEEDBACK-BUS OSCILLATION RING: A GENERAL ARCHITECTURE FOR DELAY CHARACTERIZATION AND TEST OF INTERCONNECTS  
Speakers:  
Shi-Yu Huang 1, Meng-Ting Tsai 1, Kun-Han Tsai 2 and Wu-Tung Cheng 2  
1National Tsing Hua University, TW; 2Mentor, US  
Abstract  
In this paper we propose a flexible delay characterization and test method for arbitrary die-to-die interconnects in a 3D IC. As compared to previous works, it is unique in its ability to streamline the characterization/test operations for a set of arbitrary interconnects with multiple pins sprawling multiple dies. During the Design-for-Testability stage, one common feedback-bus (connected to all dies in the IC under characterization/test) is inserted. Through the feedback-bus, an oscillation ring can be formed dynamically and the Variable-Output-Threshold (VOT) technique can be applied to characterize the delay of a selected interconnect segment at a time. Experimental results indicate that this method is not only flexible and scalable, but requiring only a small area overhead.  
Download Paper (PDF; Only available from the DATE venue WiFi)  

IP3-15  
ANALOG NEUROMORPHIC COMPUTING ENABLED BY MULTI-GATE PROGRAMMABLE RESISTIVE DEVICES  
Speakers:  
Vehbi Calayir, Mohamed Darwish, Jeffrey Weldon and Larry Pileggi, Carnegie Mellon University, US  
Abstract  
Analog neural networks represent a massively parallel computing paradigm by mimicking the human brain. Two important functions that are not efficiently built by CMOS technology for their practical hardware implementations are weighting for synapse circuits and summing for neuron circuits. In this paper we propose the use of tunable analog resistances, such as multi-gate graphene devices, to efficiently enable these two functions. We design and demonstrate a complete analog neuromorphic circuitry enabled by such devices. Simulation results based on Verilog-A compact models for graphene devices confirm its functionality. We also provide experimental demonstration of our proposed graphene device along with projected circuit performance based on scaling targets. Our proposed design is suitable not only for the device example shown in this paper, but also for any beyond-CMOS technology that exhibits similar device characteristics.  
Download Paper (PDF; Only available from the DATE venue WiFi)
**Presentations**

**UB08.1 VDA-ADMF: AN AGILE MIGRATION FRAMEWORK FOR ANALOG LAYOUT DESIGN**

**Presenter:** Po-Cheng Pan, National Chiao Tung University, TW  
**Authors:** Ching-Yu Chin¹, Hung-Ming Chen¹, Tung-Chieh Chen², Jou-Chun Lin² and Yi-Peng Weng³  
¹National Chiao Tung University, TW; ²Synopsys Co., Ltd., TW; ³Taiwan Semiconductor Manufacturing Company, TW

**Abstract:** Layout generation in the late analog CMOS design is challenging by its increasing layout constraints and performance requirements. However, iterative refinement on manual design damages the productivity of analog layout. Therefore, it is more efficient to enroll the know-how from existing design instead of generating a new one. To contend with time-consuming analog layout for more possibilities, this software aims to demonstrate a fast layout prototyping framework for migration purpose into real layout design. In our framework, a reference analog layout design is given to generate potential layout candidates at the objective technology. The demonstration includes the original layout, the extracted topology with placement and routing, the generated layout figures, the dumped layout results and the simulated results. This procedure of migration provides a convincing exhibition of our migration framework.

**UB08.2 AN FPGA LAB-ON-CHIP: AN ANALYSIS TOOL AND FRAMEWORK FOR ADVANCED MEASUREMENTS AND RELIABILITY ASSESSMENTS ON MODERN NANOSCALE FPGAS**

**Presenter:** Petr Pfeifer, Technical University of Liberec, CZ  
**Authors:**

**Abstract:** AN FPGA lab-on-chip solution is an attractive method for advanced measurements and reliability assessments on modern nanoscale FPGAs. This framework can be used for data-oriented mobile computing. It provides a convincing exhibition of our migration framework.
**UB08.4 ISP RAS VERIFICATION TOOLS: INTEGRATED APPROACH TO HARDWARE VERIFICATION AT UNIT AND SYSTEM LEVELS BASED ON STATIC AND DYNAMIC METHODS**

**Presenter:** Andrei Tatarnikov, Institute for System Programming of the Russian Academy of Sciences (ISP RAS), RU

**Authors:** Mikhail Chupilko, Alexander Kamkin, Artem Kotsynyak and Sergey Smolov, Institute for System Programming of the Russian Academy of Sciences (ISP RAS), RU

**Abstract**
Verification has long been recognized as an integral part of the hardware design process. As each hardware design is developed from unit- and core-level point of view, verification process should account this fact and provide means for dealing with both of them. Applied approaches include both static (formal methods, source code analysis) and dynamic (testing) methods. To facilitate verification, it is important to provide a uniform methodology that would allow integrating different approaches. In this work, we present a set of verification tools that take advantage exactly of combining static and dynamic approaches. This allows knowledge sharing between tools, which helps to build more accurate models of hardware designs to be used in verification activities at different levels of abstraction. Brief descriptions of the tools are given below. MicroTESK is a reconfigurable (retargetable and extendable) model-based test program generator for microprocessors and other programmable devices. Lightweight formal specifications customize the generator for a particular architecture and provide knowledge about situations to be covered by tests. A convenient test template framework allows rapid development of complex verification scenarios. Being reconfigurable, MicroTESK is able to support various RISC and CISC architectures. C++TESK is an open-source C++ based toolkit intended for automated functional testing of software components (mostly in C/C++) and RTL (HDL) models of digital hardware (in Verilog and VHDL). The main part of the tool is a library of C++ classes and macros that define facilities for constructing formal specifications (reference models), adapters of components under test, test scenarios and test coverage metrics. Basing on C++ descriptions provided by a user, a test system is compiled. It allows automatically generating and applying sequences of stimuli to the component under test, checking correctness of its reactions and collecting statistics on test execution. Besides the basic library, the toolkit includes a report generator, means for parallelizing test execution on computer clusters, and Eclipse-based IDE. The toolkit is planned to be integrated into UVN methodology. Retrascope is an extendable toolkit for RTL (HDL) models transformation and functional verification at unit level. Analyzing source HDL-code, it extracts control and data flows, transforms them into Extended Finite State Machines (EFSM), and generates covering test sequences for them. The toolkit supports RTL modules written in VHDL and Verilog. It can be used both from command line and from Eclipse-based IDE.

More information ...
INTERACTIVE VISUALIZATION OF ESL DESIGNS

Presenter:
Jannis Stoppe, University of Bremen, DE

Authors:
Robert Wille and Rolf Drechsler, University of Bremen/DFKI GmbH, DE

Abstract
In this work, we propose an improved visualization tool for SystemC which assists a designer in communicating a system’s structure and behavior. Please see the uploaded pdf-file for details.

More information ...

18:00 End of session
19:30 DATE Party in Museum of Grenoble (Musée de Grenoble, 5 Place de Lavalette, 38000 Grenoble, France)

As one of the main networking opportunities during the DATE week, the DATE Party states a perfect occasion to meet friends and colleagues in a relaxed atmosphere while enjoying local amenities. It will take place on March 11, 2015, from 19:30 to 23:00 in the renowned “Musée de Grenoble” (Grenoble Museum). This painting museum features a unique collection of ancient, modern and contemporary art including major masterpieces of classical Flemish, Dutch, Italian and Spanish painting and all the great post-1945 contemporary art-trends, right up to the most recent artwork of the 2000s.

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How to get there: The tram B has a stop called “Notre Dame Musee”. That stop is next to the Museum. Attendees would take the tram A from Alpexpo and change for Tram B in one of the stations between “Gares” and “Maison du Tourisme” to get to the museum. The trip takes about 30 minutes.

8.1 SPECIAL DAY Panel: Security and Verification for the IoT
Date: Wednesday 11 March 2015
Time: 17:00 - 18:30
Location / Room: Salle Oisans

Organisers:
Rolf Drechsler, University of Bremen/DFKI GmbH, DE
Dominique Borrione, TIMA Lab, UGA, FR

Chair:
Dominique Borrione, TIMA Lab, UGA, FR

Co-Chair:
Guy Gogniat, Lab-STICC, Université de Bretagne-Sud, Lorient, FR

Panelists:
- Erdinc Ozturk, Ticaret University, TR
- Guido Bertoni, STMicroelectronics, IT
- Francois-Xavier Standaert, Université Catholique de Louvain, BE
- Christoph Grimm, University of Kaiserslautern, DE
- Sandip Kundu, University of Massachusetts Amherst, US

18:30 End of session
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8.2 Flash Memories & Numerical Approximation

Date: Wednesday 11 March 2015
Time: 17:00 - 18:30
Location / Room: Belle Etoile
Chair: Philippe Coussy, Université de Bretagne-Sud, FR
Co-Chair: Zili Shao, HongKong Polytechnic University, HK

This session presents papers on flash memories and numerical approximations. The first paper presents a new flash memory management scheme to extend the product lifetime of SSDs. The second paper describes a hardware accelerator approach for solving linear equations. The third paper describes an approach for automatically synthesizing non-linear 2D function approximations without requiring costly, and power-hungry, multipliers. Finally, the session ends with two interactive presentations that address progressive wear-leveling for flash memories, and security threats and countermeasures for solid-state drives.

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<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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<tr>
<td>17:00</td>
<td>8.2.1</td>
<td>HLC: SOFTWARE-BASED HALF-LEVEL-CELL FLASH MEMORY</td>
<td>Han-Yi Lin¹ and Jen-Wei Hsieh ²</td>
</tr>
</tbody>
</table>

¹National Taiwan University, TW; ²National Taiwan University of Science and Technology, TW

Abstract

In recent years, flash memory has been widely used in embedded systems, portable devices, and high-performance storage products due to its non-volatility, shock resistance, low power consumption, and high performance natures. To reduce the product cost, multi-level-cell flash memory (MLC) has been proposed; compared with the traditional single-level-cell flash memory (SLC) that only stores one bit of data per cell, each MLC cell can store two or more bits of data. Thus MLC can achieve a larger capacity and reduce the cost per unit. However, MLC also suffers from the degradation in both performance and reliability. In this paper, we try to enhance the reliability and reduce the product cost of flash-memory based storage devices from a totally different perspective. We propose a half-level-cell (HLC) management scheme to manage and reuse the worn-out space in solid-state drives (SSDs); through our management scheme, the system can treat two corrupted pages as a normal page without sacrificing performance and reliability. To the best of our knowledge, this is the first research that reclaims free space by reviving the corrupted pages. The experiment results show that the lifetime of SSD can be extended by 48.54% for the trace of general users applications with our proposed HLC management scheme.

Download Paper (PDF, Only available from the DATE venue WiFi)
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<tr>
<td>17:30</td>
<td>8.2.2</td>
<td><strong>AHEAD: AUTOMATED FRAMEWORK FOR HARDWARE ACCELERATED ITERATIVE DATA ANALYSIS</strong></td>
<td>Ebrahim M. Songhori, Xuyang Lu and Farinaz Koushanfar, Rice University, US</td>
</tr>
</tbody>
</table>

**Abstract**

This paper introduces AHEAD, a novel domain-specific framework for automated (hardware-based) acceleration of massive data analysis applications with a dense (non-sparse) correlation matrix. Due to non-scalability of matrix inversion, often iterative computation is used for converging to a solution. AHEAD addresses two sets of domain-specific matrix computation challenges. First, the I/O and memory bandwidth constraints which limit the performance of hardware accelerators. Second, the hardness of handling large data because of the complexity of the known matrix transformations and the inseparability of non-sparse correlations. The inseparability problem translates to an increased communication cost with the accelerators. To optimize the performance within these limits, AHEAD learns the dependency structure of the domain data and suggests a scalable matrix transformation. The transformation minimizes the memory access required for matrix computing within an error threshold and thus, optimizes the mapping of domain data to the available (bandwidth constrained) accelerator resources. To facilitate automation, AHEAD also provides an Application Programming Interface (API) so users can customize the framework to an arbitrary iterative analysis algorithm and hardware mapping. Proof-of-concept implementation of AHEAD is performed on the widely used compressive sensing and general l2 regularized least squares solvers. On a massive light field imaging data set with 4.6B non-zeros, AHEAD attains up to 320x iteration speed improvement using reconfigurable hardware accelerators compared with the conventional solver and about 4x improvement compared to our transformed matrix solver on a general purpose processor (without hardware acceleration).

Download Paper (PDF; Only available from the DATE venue WiFi)

| 18:00 | 8.2.3 | **DESIGN METHOD FOR MULTIPLIER-LESS TWO-VARIABLE NUMERIC FUNCTION APPROXIMATION** | Jochen Rust and Steffen Paul, University of Bremen, DE |

**Abstract**

In this paper a novel method for hardware-based realization of two-variable numeric functions is introduced. The main idea is based on the extension of the well-known piecewise linear approximation technique, which is often used for the calculation of one-variable elementary functions. A non-uniform and plane segmentation scheme enables quick segment access at runtime; the use of multiplier-less linear equations causes high performance in terms of throughput. As both the extraction of approximation-related parameters and its mapping to corresponding hardware elements is automated, the design time is also reduced to a minimum. For evaluation, several approximations with varying constraints are generated and compared on the algorithmic level to one another as well as to actual references. In conjunction with the results of logical and physical CMOS synthesis, our work turns out to be highly efficient in terms of throughput, memory requirements and energy consumption.

Download Paper (PDF; Only available from the DATE venue WiFi)

| 18:30 | IP4-1 | **PWL: A PROGRESSIVE WEAR LEVELING TO MINIMIZE DATA MIGRATION OVERHEADS FOR NAND FLASH DEVICES** | Fu-Hsin Chen, Ming-Chang Yang, Yuan-Hao Chang and Tei-Wei Kuo |

**Speakers:**

1Department of Computer Science and Information Engineering, National Taiwan University, TW; 2Graduate Institute of Networking and Multimedia, National Taiwan University, TW; 3Institute of Information Science, Academia Sinica, TW; 4Academia Sinica & National Taiwan University, TW

**Abstract**

As the endurance of flash memory keeps deteriorating, exploiting wear leveling techniques to improve the lifetime/endurance of flash memory has become a critical issue in the design of flash storage devices. In contrast to existing wear-leveling techniques that aggressively distributes the erases to all flash blocks by a fixed threshold, we propose a progressive wear leveling design to perform wear leveling in a "progressive" way to prevent any block from being worn out prematurely, and thereby to ultimately minimize the performance overheads caused by the unnecessary data migration. The results reveal that, instead of sacrificing the device lifetime, performing wear leveling in such a progressive way can not only minimize the performance overheads but even have potentials to extend the device lifespan.

Download Paper (PDF; Only available from the DATE venue WiFi)

| 18:30 | IP4-2 | **TOWARDS TRUSTABLE STORAGE USING SSDS WITH PROPRIETARY FTL** | Xiaotong Cui, Minhui Zou, Liang Shi and Kaijie Wu |

**Speakers:**

1Chongqing University, CN; 2College of Computer Science, Chongqing University, CN

**Abstract**

In recent years, we have seen an increasing deployment of flash-based storage, such as SSD, in mission-critical applications due to its fast read/write speed, small form factor, strong shock resistance, and etc. SSD uses a host interface and a middle layer called flash translation layer (FTL) to maintain the compatibility with the traditional magnetic-based HDD. Unlike the traditional HDD where the host OS has the full control on where to access the data, SSD uses FTL to translate and implement all operations, and OS has no such control. Even worse, FTL, which is considered as one of most important intellectual property of SSD, is often proprietary. This brings up a security concern on design trustworthiness: what if the manufacturer either accidentally or intentionally implement those operations incorrectly or even maliciously? In this paper we analyze the possible threats and propose a simple yet effective countermeasure.

Download Paper (PDF; Only available from the DATE venue WiFi)

18:30

End of session
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**How to get there:** The tram B has a stop called "Notre Dame Musee". That stop is next to the Museum. Attendees would take the tram A from Alpexpo and change for Tram B in one of the stations between "Gares" and "Maison du Tourisme" to get to the museum. The trip takes about 30 minutes.
Abstract
Heterogeneous multiprocessor system-on-chip (MPSoCs) powering mobile platforms integrate multiple asymmetric CPU cores, GPUs, and many specialized processors. When the MPSoC operates close to its peak power, power dissipation easily increases the temperature, hence adversely impacts reliability. Since using a fan is not a viable solution for hand-held devices, there is a strong need for dynamic thermal and power management (DTPM) algorithms that can regulate temperature with minimal performance impact. This paper presents a DTPM algorithm based on a practical temperature prediction methodology using system identification. The DTPM algorithm dynamically computes a power budget using the predicted temperature, and controls the types and number of active processors as well as their frequencies. Experiments on an octa-core big.LITTLE processor and common Android apps demonstrate that the proposed technique predicts temperature within 3% accuracy, while the DTPM algorithm provides around 6x reduction in temperature variance, and as large as 16% reduction in total platform power compared to using a fan.

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8.4 Industrial System Design Opportunities

Date: Wednesday 11 March 2015  
Time: 17:00 - 18:30  
Location / Room: Chartreuse

Chair: Norbert Wehn, University of Kaiserslautern, DE  
Co-Chair: David Raphael, CEA-LIST, FR

This session introduces Innovative experiments from Industry that address the challenges of system design. Each experiment presents a demonstrator and shows a substantial measurable economic and or strategic impact.
A NEW DISTRIBUTED FRAMEWORK FOR INTEGRATION OF DISTRICT ENERGY DATA FROM HETEROGENEOUS DEVICES

Speakers:
Francesco Gavino Brundu

Abstract
A programmable video decoding system with multi-core DSP and co-processors is presented. This system is adopted by Digital TV System on Chip (SoC) and is used for FHD High Efficiency Video Coding (HEVC) decoder under 400MHz. Using the DSP based programmable solution, we can reduce commercialization period by one year because we can parallelize algorithm development, software optimization and hardware design. In addition to the HEVC decoding, the proposed system can be used for other application such as other video decoding standard for multi-format decoder or video quality enhancement.

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8.5 Hot Topic - Spintronics based Computing

Date: Wednesday 11 March 2015
Time: 17:00 - 18:30
Location / Room: Meije

Organisers:
Weisheng Zhao, University Paris-Sud/CNRS, FR
Lionel Torres, LIRMM, CNRS/University of Montpellier, FR

Chair:
Lionel Torres, LIRMM, CNRS/University of Montpellier, FR

Co-Chair:
Weisheng Zhao, University Paris-Sud/CNRS, FR

Thanks to its non-volatility, fast data access, low power and infinite endurance, Spintronics (Nobel Prize 2007) is considered as one of the major technologies beyond CMOS to overcome the power and speed bottlenecks of advance computing systems. This topic is under intense study from device to system levels by both academics and industries. This session brings together the worldwide leading experts to share their recent results and discuss future challenges.
**Abstract**

Processing the data deluge using current CMOS architectures requires a tremendous amount of energy, as the latter has proved to lack efficiency in tasks such as data mining, recognition and synthesis. Alternative models of computation such as neuromorphics can be more efficient for this kind of tasks, but do not map ideally to traditional CMOS. Spintronics, in contrast, can offer features such as embedded nonvolatile memory, stochastic and memristive behavior, which, when associated with CMOS, can be key enablers of neuromorphic computing. In this paper, we explore different works that go in this direction. First, we illustrate how recent developments of embedded nonvolatile memory based on magnetic tunnel junctions (MTJs) can ideally provide the large amount of nonvolatile memory required in neu-inspired designs, while avoiding Von Neumann bottleneck. Second, we show that recently developed spintronics memristors can implement artificial synapses for neuromorphic systems. With a more breakthrough design, we show how probabilistic writing of a single MTJ bit can efficiently replace multi-level weighting in some classes of neuromorphic architectures. Finally, we show that a special class of MTJs can exhibit the phenomenon of stochastic resonance, a strategy used in biological systems to detect weak signals. These results suggest that the impact of spintronics may go far beyond the traditional standalone and embedded memory markets.

**Download Paper (PDF; Only available from the DATE venue WiFi)**
19:30  **DATE Party in Museum of Grenoble (Musée de Grenoble, 5 Place de Lavalette, 38000 Grenoble, France)**

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**8.6 Statistical Answers to Analog/Mixed Signal Design and Test Problems**

**Date:** Wednesday 11 March 2015  
**Time:** 17:00 - 18:30  
**Location / Room:** Bayard

**Chair:**  
Jacob Abraham, The University of Texas at Austin, US

**Co-Chair:**  
Michel Renovell, LIRMM/CNRS, FR

The session will demonstrate applications of Bayesian model fusion, machine learning classifiers, feature selection, virtual probe, and Quasi Monte Carlo for solving challenging design and test problems for analog and mixed signal circuits.
18:30 8.6.1 EFFICIENT BIT ERROR RATE ESTIMATION FOR HIGH-SPEED LINK BY BAYESIAN MODEL FUSION

Speakers: Chenlei Fang¹, Qicheng Huang¹, Fan Yang¹, Xuan Zeng¹, Xin Li² and Chenjie Gu³

¹Fudan University, CN; ²Carnegie Mellon University and Fudan University, US; ³Strategic CAD Labs, Intel Corporation, US

Abstract
High-speed I/O link is an important component in computer systems, and estimating its bit error rate (BER) is a critical task to guarantee its performance. In this paper, we propose an efficient method to estimate BER by Bayesian Model Fusion. Its key idea is to borrow conventional extrapolated BER value as prior knowledge, and combine it with additional measurement data to "calibrate" the BER value. This method can be viewed as an application of Bayesian Model Fusion (BMF) technique. We further propose some novel methodologies to make BMF applicable in the BER estimation case. In this way, we can sufficiently decrease the number of bits needed to estimate BER value. Several experiments demonstrate that our proposed method achieves up to 8x speed-up over direct estimation method.

Download Paper (PDF; Only available from the DATE venue WiFi)

18:30 8.6.2 FAST DEPLOYMENT OF ALTERNATE ANALOG TEST USING BAYESIAN MODEL FUSION

Speakers: John Laplace¹, Haralampos Stratigopolous², Louay Abdallah², Yiorgos Tsiotouhas³ and Xin Li⁴

¹Technological Educational Institute of Peloponnese, GR; ²TIMA Laboratory, Université de Grenoble-Alpes/CNRS, FR; ³University of Ioannina, GR; ⁴National and Kapodistrian University of Athens, GR; ⁵Carnegie Mellon University, US

Abstract
In this paper, we address the problem of limited training sets for learning the regression functions in alternate analog test. Typically, a large volume of real data needs to be collected from different wafers and lots over a long period of time to be able to train the regression functions with accuracy across the whole design space and apply alternate test with high confidence. To avoid this delay and achieve a fast deployment of alternate test, we propose to use the Bayesian model fusion technique that leverages prior knowledge from simulation data and fuses this information with data from few real circuits to draw accurate regression functions across the whole design space. The technique is demonstrated for an alternate test designed for RF low noise amplifiers.

Download Paper (PDF; Only available from the DATE venue WiFi)

18:00 8.6.3 BORDERSEARCH: AN ADAPTIVE IDENTIFICATION OF FAILURE REGIONS

Speakers: Markus Dobler¹, Manuel Harrant², Monica Rafaela³, Georg Pelz³, Wolfgang Rosenstiel¹ and Martin Bogdan³

¹University of Tübingen, DE; ²Infineon Technologies, DE; ³University of Tübingen, Leipzig University, DE

Abstract
The reliability and safety of modern analog devices, e.g. in automobiles, aircraft or consumer electronics, is influenced by many input parameters like supply voltage, ambient temperature or load resistances. In certain regions of this large parameter space, the device exhibits degraded performance or it fails completely. The validity of such a device has to find the regions of the input parameter space in which the device misbehaves. However, with several parameters, it is a complex task to determine these regions, especially if parameters interact. In this paper, we present the Bordersearch algorithm, which combines adaptive testing with a machine learning classifier to efficiently determine the border between passing and failing regions in the parameter space. Furthermore, this method enables sophisticated post-processing analysis, e.g. better visualizations and automatic ranking of the parameters according to their influence. This algorithm scales well to a high-dimensional parameter space and is robust against outliers and fuzzy borders. We show the effectiveness of this method on an automotive electro-mechanical system with eleven input parameters.

Download Paper (PDF; Only available from the DATE venue WiFi)

18:15 8.6.4 A FAST SPATIAL VARIATION MODELING ALGORITHM FOR EFFICIENT TEST COST REDUCTION OF ANALOG/RF CIRCUITS

Speakers: Hugo Gonçalves¹, Xin Li², Miguel Correia³, Vitor Tavares³, John Carulli⁴ and Kenneth Butler⁵

¹CMU/FEUP, PT; ²Carnegie Mellon University, US; ³FEUP, PT; ⁴GLOBALFOUNDRIES, US; ⁵Texas Instruments, US

Abstract
In this paper, we adopt a novel numerical algorithm, referred to as dual augmented Lagrangian method (DALM), for efficient test cost reduction based on spatial variation modeling. The key idea of DALM is to derive the dual formulation of the L1-regularized least-squares problem posed by Virtual Probe (VP), which can be efficiently solved with substantially lower computational cost than its primal formulation. In addition, a number of unique properties associated with discrete cosine transform (DCT) are exploited to further reduce the computational cost of DALM. Our experimental results of an industrial RF transceiver demonstrate that the proposed DALM solver achieves up to 38x runtime speed-up over the conventional interior-point solver without sacrificing any performance on escape rate and yield loss for test applications.

Download Paper (PDF; Only available from the DATE venue WiFi)

18:30 8.6.5 IP4-5, 656

A HYBRID QUASI MONTE CARLO METHOD FOR YIELD AWARE ANALOG CIRCUIT SIZING TOOL

Speakers: Engin Afacan, Günhan Dündar, Gonenc Berkol, Ali Emre Pusane and Ismail Feik Baskaya, Bogazici University, TR

Abstract
Efficient yield estimation methods are required by yield aware automatic sizing tools, where many iterative variability analyses are performed. Quasi Monte Carlo (QMC) is a popular approach, in which samples are generated more homogeneously, hence faster convergence is obtained compared to the conventional MC. However, since QMC is deterministic and has no natural variance, there is no convenient way to obtain estimation error bounds. To overcome this issue, we propose a hybrid method, where a single QMC is performed to determine infeasible solutions in terms of yield, which is followed by a few scrambled QMC analyses providing variance and confidence interval of the estimated yield. Yield optimization is performed considering the worst case of the current estimation, thus the optimizer guarantees that the solution will satisfy the confidence interval. Furthermore, a yield ranking mechanism is also developed to enhance the optimizer to search for more robust solutions.

Download Paper (PDF; Only available from the DATE venue WiFi)

18:31 8.6.6 IP4-6, 179

FEATURE SELECTION FOR ALTERNATE TEST USING WRAPPERS: APPLICATION TO AN RF LNA CASE STUDY

Speakers: Manuel Barragan¹ and Gildas Leger²

¹TIMA Laboratory, FR; ²Instituto de Microelectronicas de Sevilla, IMSE-CNM, (CSIC - Universidad de Sevilla), ES

Abstract
Testing analog, mixed-signal and RF circuits represents the main cost component for testing complex SoCs. A promising solution to alleviate this cost is the Alternate Test strategy. Alternate test is an indirect test approach that replaces costly specification measurements by simpler signatures. Machine learning techniques are then used to map signatures and performances. One key point that still remains as an open problem is the conception of adequate simple measurement candidates. This work presents efficient algorithms for selecting information rich signatures.

Download Paper (PDF; Only available from the DATE venue WiFi)

18:30 End of session
As one of the main networking opportunities during the DATE week, the DATE Party states a perfect occasion to meet friends and colleagues in a relaxed atmosphere while enjoying local amenities. It will take place on March 11, 2015, from 19:30 to 23:00 in the renowned “Musée de Grenoble” (Grenoble Museum). This painting museum features a unique collection of ancient, modern and contemporary art including major masterpieces of classical Flemish, Dutch, Italian and Spanish painting and all the great pot-1945 contemporary art-trends, right up to the most recent artwork of the 2000s.

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How to get there: The tram B has a stop called “Notre Dame Musee”. That stop is next to the Museum. Attendees would take the tram A from Alpexpo and change for Tram B in one of the stations between “Gares” and “Maison du Tourisme” to get to the museum. The trip takes about 30 minutes.

8.7 Compilers and Tools for Performance

Date: Wednesday 11 March 2015
Time: 17:00 - 18:30
Location / Room: Les Bans

Chair: Frank Hannig, Friedrich-Alexander-Universität Erlangen-Nürnberg, DE
Co-Chair: Christian Haubelt, University of Rostock, DE

This session introduces different aspects of optimizing compiler technology in the context of embedded systems. The first paper shows that the performance of Android applications can be significantly improved by ahead-of-time compilation to C. The second paper shows how to generate efficient vector code from domain-specific (linear algebra) specifications. The first interactive presentation presents a technique to speed up the QEMU machine emulator by dynamic binary translation of vector instructions. The second one proposes a trace-based reuse distance profiler to help improving the memory profile of applications.

8.7.1 BYTECODE-TO-C AHEAD-OF-TIME COMPILATION FOR ANDROID DALVIK VIRTUAL MACHINE

Speakers: Hyeong-Seok Oh, Ji Hwan Yeo and Soo-Mook Moon, Seoul National University, KR

Abstract
Android employs Java for programming its apps which is executed by its own virtual machine called the Dalvik VM (DVM). One problem of the DVM is its performance. Its just-in-time compiler (JITC) cannot generate high-performance code due to its trace-based compilation with short traces and modest optimizations, compared to JVM’s method-based compilation with ample optimizations. This paper proposes a bytecode-to-C ahead-of-time compilation (AOTC) for the DVM to accelerate pre-installed apps. We translated the bytecode of some of the hot methods used by these apps to C code, which is then compiled together with the DVM source code. AOTC-generated code works with the existing Android zygote mechanism, with corrects garbage collection and exception handling. Due to off-line, method-based compilation using existing compiler with full optimizations and Java-specific optimizations, AOTC can generate quality code while obviating runtime compilation overhead. For benchmarks, AOTC can improve the performance by 10% to 500%. When we compare this result with the recently-introduced ART, which also performs ahead-of-time compilation, our AOTC performs better.

Download Paper (PDF; Only available from the DATE venue WiFi)
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<th>Time</th>
<th>Label</th>
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<tr>
<td>17:30</td>
<td>8.7.2</td>
<td>A BASIC LINEAR ALGEBRA COMPILER FOR EMBEDDED PROCESSORS</td>
<td>Nikolaos Kyrtatas, Daniele Giuseppe Spampinato and Markus Püschel, Swiss Federal Institute of Technology in Zurich (ETHZ), CH</td>
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<td><strong>Abstract</strong></td>
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<td>Many applications in signal processing, control, and graphics on embedded devices require efficient linear algebra computations. On general-purpose computers, program generators have proven useful to produce such code, or important building blocks, automatically. An example is LGen, a compiler for basic linear algebra computations of fixed size. In this work, we extend LGen towards the embedded domain using as example targets Intel Atom, ARM Cortex-A8, ARM Cortex-A9, and ARM1176 (Raspberry Pi). To efficiently support these processors we introduce support for the NEON vector ISA and a methodology for domain-specific load/store optimizations. Our experimental evaluation shows that the new version of LGen produces code that performs in many cases considerably better than well-established, commercial and non-commercial libraries (Intel MKL and IPP), software generators (Eigen and ATLAS), and compilers (icc, gcc, and clang).</td>
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<td>18:00</td>
<td>8.7.3</td>
<td>VARSHA: VARIATION AND RELIABILITY-AWARE APPLICATION SCHEDULING WITH ADAPTIVE PARALLELISM IN THE DARK-SILICON ERA</td>
<td>Nisbit Kapadia and Sudeep Pasricha, Colorado State University, US</td>
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<td><strong>Abstract</strong></td>
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<td>We propose a novel framework that leverages the knowledge of variations on the chip to perform runtime application mapping and dynamic voltage scaling to optimize system performance and energy, while satisfying dark-silicon power constraints of the chip as well as application-specific performance and reliability constraints. Our experimental results show average savings of 35%-80% in application service-times and 13%-15% in energy consumption, compared to the state-of-the-art.</td>
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<td>18:30</td>
<td>IP4-7</td>
<td>IMPROVING SIMD CODE GENERATION IN QEMU</td>
<td>Sheng-Yu Fu¹, Jan-Jan Wu² and Wei-Chung Hsu¹</td>
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<td><strong>Abstract</strong></td>
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<td>Modern processors are often enhanced with SIMD instructions. For examples, the MMX, SSE, and AVX instruction set in the x86 architecture, and the Neon instruction set in the ARM architecture are SIMD instructions. Using these SIMD instructions could significantly increase the performance of applications, hence application binaries are likely to have a good fraction of instructions that are SIMD instructions. However, SIMD instruction translation has not attacked much attention in Dynamic Binary Translation (DBT). For example, in the popular QEMU system emulator, guest SIMD instructions are often emulated with a sequence of scalar instructions even when the host machines do have SIMD instructions to support such parallel computation, leaving a large potential for performance enhancement. In this paper, we propose two approaches, one to leverage the existing helper function implementation in QEMU, and the other to use a newly introduced vector IR (Intermediate Representation) to enhance the performance of SIMD instructions translation in DBT of QEMU. The approaches have been implemented in the QEMU to support ARM and IA32 frontend and x86-64 backend. Our preliminary experiments show that adding vector IR can significantly enhance the performance of guest applications containing SIMD instructions for both ARM and IA32 architectures when running with QEMU on the x86-64 platform.</td>
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<td>18:31</td>
<td>IP4-8</td>
<td>REUSE DISTANCE ANALYSIS FOR LOCALITY OPTIMIZATION IN LOOP-DOMINATED APPLICATIONS</td>
<td>Christakis Lezos, Grigoris Dimitroulakos and Konstantinos Masselos, University of Peloponnese, GR</td>
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<td><strong>Abstract</strong></td>
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<td>This paper discusses MemAddIn, a compiler assisted dynamic code analysis tool that analyzes C code and exposes critical parts for memory related optimizations on embedded systems that can heavily affect systems performance, power and cost. The tool includes enhanced features for data reuse distance analysis and source code transformation recommendations for temporal locality optimization. Several of data reuse distance measurement algorithms have been implemented leading to different trade-offs between accuracy and profiling execution time. The proposed tool can be easily and seamlessly integrated into different software development environments offering a unified environment for application development and optimization. The novelities of our work over a similar optimization tool are also discussed. MemAddIn has been applied for the dynamic computation of data reuse distance for a number of different applications. Experimental results prove the effectiveness of the tool through the analysis and optimization of a realistic image processing application.</td>
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<td>End of session</td>
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8.8 Share a Fab - Multi Project Wafers Enable Your Innovations

Date: Wednesday 11 March 2015
Time: 17:00 - 18:30
Location / Room: Salle Lesdiguières

Moderator:
Andreas Vörg, edacentrum, DE

Today most innovations in the major industries include the use of dedicated chips. However, extremely high IC fabrication costs and foundries accepting only orders with high quantities are substantial obstacles for innovations developed from SMEs, start-ups, universities and research organisations.

The solution is that many of these innovators team up and share a fab run by using the opportunities offered by Multi Project Wavers (MPWs). European service providers like Europractice and CMP provide the access to MPW runs as well as the required know-how and tooling.

In the tutorial part of this session first-time users as well as experienced users will be provided with comprehensive information about the available semiconductor technologies, new design methodologies and possible applications. In the best practice part of the session users of such services will share their experience with the MPW concept with the audience and present projects and products realized by utilizing MPW opportunities.
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### 9.1 SPECIAL DAY Hot Topic: Game-changing Innovative Technology Platforms for Health Care

**Date:** Thursday 12 March 2015  
**Time:** 08:30 - 10:00  
**Location / Room:** Salle Oisans

**Organiser:**  
Jo De Boeck, IMEC, BE

**Chair:**  
Jo De Boeck, IMEC, BE

After an introductory talk on the future impact of electronics in health care innovation, the panel of experts from industry will discuss the main trends they see and the challenges this presents for technology and care providers.

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<tr>
<td>08:30</td>
<td>9.1.1</td>
<td>GAME CHANGING INNOVATION IN TECHNOLOGY AND DESIGN FOR EFFECTIVE HEALTH CARE</td>
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<td>Speaker: Chris Van Hoof, IMEC, BE</td>
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|        |       | **Abstract**  
Vision and positioning the talks of the day in perspective to the overall challenge. |
| 09:00  | 9.1.2 | ADVANCED SELF-POWERED SYSTEMS OF INTEGRATED SENSORS AND TECHNOLOGIES                 |
|        |       | Speaker: Veena Misra, ASSIST, NC State University, US                             |
|        |       | **Abstract**  
Development of nano-enabled energy harvesting, energy storage, nanodevices, and sensors enables innovative battery-free, body-powered, and wearable health monitoring systems. One of challenges addressed in this presentation is developing efficient ways to harness energy from the human body or the environment, convert it to usable forms, and store it in ultra-high-density capacitors. Another focal point of research is low-Power nanoelectronics with the aim to design low-power electronics and antennae. |
HEALTHCARE IN AN INTEGRATED DIGITAL WORLD

Speaker: Jean-Paul Linhartz, Philips, NL

Abstract
Integration (IC) technology, smart systems and large scale analysis of measurements and data are rapidly innovating many aspects of the healthcare system. This includes innovations in imaging such as enhancing the resolution, ability to differentiate between tissues and compensation of artifacts. Many imaging modalities require advanced signal handling, often in massively parallel structures. At the same time, miniaturization of sensors and actuators paves the way for minimally invasive in-body devices for diagnostics and for interventions, which then become part of integrated interventional solutions.

End of session

Coffee Break in Exhibition Area

Coffee Break in Exhibition Area

On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area.

Lunch Break

On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Ecrrins (for fully registered conference delegates only).

Tuesday, March 10, 2015
Coffee Break 10:30 - 11:30
Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
Coffee Break 16:00 - 17:00

Wednesday, March 11, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)
Coffee Break 16:00 - 17:00

Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

9.2 Hot Topic - Transparent Use of Accelerators in Heterogeneous Computing Systems

| Date: Thursday 12 March 2015 |
| Time: 08:30 - 10:00 |
| Location / Room: Belle Etoile |

Organisers:
Heiner Giefers, IBM Research Zurich, CH
Christian Plessl, University of Paderborn, DE

Chair:
Christian Plessl, University of Paderborn, DE

Co-Chair:
Heiner Giefers, IBM Research Zurich, CH

This hot topic session discusses recent research for transparent compilation and offloading of computational hotspots from CPUs to accelerators, in particular, many-core processors and FPGAs. The overarching objective of these approaches is to make the performance and energy-efficiency benefits of heterogeneous computing available to a broader spectrum of applications and users by reducing or even obviating the effort for porting applications.

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<tr>
<td>08:30</td>
<td>9.2.1</td>
<td>TRANSPARENT ACCELERATION OF PROGRAM EXECUTION USING RECONFIGURABLE HARDWARE</td>
<td>Nuno Paulino 1, João Canas Ferreira 1, João Bispo 2 and João M. P. Cardoso 2</td>
</tr>
</tbody>
</table>

1INESC TEC and Faculty of Engineering, PT; 2University of Porto, PT

Abstract
The acceleration of applications, running on a general purpose processor (GPP), by mapping parts of their execution to reconfigurable hardware is an approach which does not involve program's source code and still ensures program portability over different target reconfigurable fabrics. However, the problem is very challenging, as suitable sequences of GPP instructions need to be translated/mapped to hardware, possibly at runtime. Thus, all mapping steps, from compiler analysis and optimizations to hardware generation, need to be both efficient and fast. This paper introduces some of the most representative approaches for binary acceleration using reconfigurable hardware, and presents our binary acceleration approach and the latest results. Our approach extends a GPP with a Reconfigurable Processing Unit (RPU), both sharing the data memory. Repeating sequences of GPP instructions are migrated to an RPU composed of functional units and interconnect resources, and able to exploit instruction-level parallelism, e.g., via loop pipelining. Although we envision a fully dynamic system, currently the RPU resources are selected and organized offline using execution trace information. We present implementation prototypes of the system on a Spartan-6 FPGA with a MicroBlaze as GPP and the very encouraging results achieved with a number of benchmarks.

Download Paper (PDF; Only available from the DATE venue WiFi)
9.2.2 ACCELERATING ARITHMETIC KERNELS WITH COHERENT ATTACHED FPGA COPROCESSORS

Speakers:
Heiner Giefers, Raphael Polig and Christoph Hagleitner, IBM Research Zurich, CH

Abstract
The energy efficiency of computer systems can be increased by migrating computational kernels that are known to under-utilize the CPU to an FPGA based coprocessor. In contrast to traditional I/O-based coprocessors that require explicit data movement, coherently attached accelerators can operate on the same virtual address space than the host CPU. A shared memory organization enables widely accepted programming models and helps to deploy energy efficient accelerators in general purpose computing systems. In this paper we study an FFT accelerator on FPGA attached via the Coherent Accelerator Processor Interface (CAPI) to a POWER8 processor. Our results show that the coherently attached accelerator outperforms device driver based approaches in terms of latency. Hardware acceleration delivers a 5x gain in energy efficiency compared to an optimized parallel software FFT running on a 12-core CPU and improves single thread performance by more than 2x. We conclude that the integration of CAPI into heterogeneous programming frameworks such as OpenCL will facilitate latency critical operations and will further enhance programmability of hybrid systems.

Download Paper (PDF; Only available from the DATE venue WiFi)

09:00 - 09:30 Coffee Break

09:15 9.2.3 TRANSPARENT OFFLOADING OF COMPUTATIONAL HOTSPOTS FROM BINARY CODE TO XEON PHI

Speakers:
Marvin Damschen¹, Heinrich Riebler², Gavin Vaz² and Christian Plessl²
¹Karlsruhe Institute of Technology (KIT), DE; ²University of Paderborn, DE

Abstract
In this paper, we study how binary applications can be transparently accelerated with novel heterogeneous computing resources without requiring any manual porting or developer-provided hints. Our work is based on Binary Acceleration At Runtime (BAAR), our previously introduced binary acceleration mechanism that uses the LLVM Compiler Infrastructure. BAAR is designed as a client-server architecture. The client runs the program to be accelerated in an environment, which allows program analysis and profiling and identifies and extracts suitable program parts to be offloaded. The server compiles and optimizes these offloaded program parts for the accelerator and offers access to these functions to the client with a remote procedure call (RPC) interface. Our previous work proved the feasibility of our approach, but also showed that communication time and overheads limit the granularity of functions that can be meaningfully offloaded. In this work, we motivate the importance of a lightweight, high-performance communication between server and client and present a communication mechanism based on the Message Passing Interface (MPI). We evaluate our approach by using an Intel Xeon Phi 5110P as the acceleration target and show that the communication overhead can be reduced from 40% to 10%, thus enabling even small hotspots to benefit from offloading to an accelerator.

Download Paper (PDF; Only available from the DATE venue WiFi)

09:37 9.2.4 TRANSPARENT LINKING OF COMPILED SOFTWARE AND SYNTHESIZED HARDWARE

Speakers:
David Thomas¹, Shane T. Fleming¹, George A. Constantinides¹ and Dan R. Ghica²
¹Imperial College London, GB; ²University of Birmingham, GB

Abstract
Modern heterogeneous systems contain tightly coupled CPU and FPGA logic, allowing low latency access to accelerators. However, designers of the system need to treat accelerated functions specially, with device specific code for instantiating, configuring, and executing accelerators. We present a system level linker, which allows functions in hardware and software to be linked together to create heterogeneous systems. The linker works with post-compilation and post-synthesis components, allowing the designer to transparently move functions between devices simply by linking in either hardware or software object files.

The linker places no special emphasis on the software, allowing computation to be initiated from within hardware, with function calls to software to provide services such as file access. A strong type-system ensures that individual code artifacts can be written using the conventions of that domain (C, HLS, VHDL), while allowing direct and transparent linking.

Download Paper (PDF; Only available from the DATE venue WiFi)

10:00 End of session

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Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)
Coffee Break 16:00 - 17:00

Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

9.3 NoC Optimization

Date: Thursday 12 March 2015
Time: 08:30 - 10:00
Location / Room: Stendhal

Chair:
Marcello Coppola, STMicroelectronics, FR

Co-Chair:
José Flich, Universidad Politecnica de Valencia, ES
As NoCs are becoming mature technology, the time is coming to develop sophisticated system-level optimization techniques. In this session, several distinct optimization techniques are addressed. The first paper presents a novel approach to traffic isolation, the second paper deals with power-saving technique exploration and the final paper develops customized NoCs for emerging biomedical applications.

**Presentation Title:** Rate-Based vs Delay-Based Control for DVFS in NoC

**Authors:**
- Mario R. Casu and Paolo Giacone, Politecnico di Torino, Department of Electronics and Telecommunications, IT

**Abstract:**
Minimization of power via DVFS in an NoC is possible, but may result in an intolerable increase of network delay. We examined two DVFS policies, a rate-based policy that scales down frequency and voltage to the minimum value that allows to sustain the injection rate without causing saturation, and a delay-based policy in which a closed-loop control tunes frequency and voltage such that the NoC average delay tracks a target value. We evaluated the power-delay trade-off by means of network simulations and accurate power estimations after synthesis on a 28-nm FDSOI CMOS technology. Our result over synthetic and multimedia traffic patterns show that the first policy largely pays the better saving in power (20%-50% less than the second policy) with a large network delay increase (up to 3x). We then conclude that the delay-based policy offers a better power-delay trade-off.

**Download Paper (PDF; Only available from the DATE venue WiFi)**

**Presentation Title:** Malleable NoC: Dark Silicon Inspired Adaptable Network on Chip

**Authors:**
- Haseeb Bokhari, Haris Javaid, Muhammad Shafique, Joerg Henkel and Sri Parameswaran

**Abstract:**
Network on Chip (NoC) has been envisioned as a scalable fabric for many core chips. However, NoCs can consume a considerable share of chip power. Moreover, diverse applications are executed in these multicore, where each application imposes a unique load on the NoC. To realise a NoC which is Energy and Delay efficient, we propose combining multiple VF optimized routers for each node (in traditional NoCs, we have only a single router per node) for efficient NoC for Dark Silicon chips. We present a generic NoC with routers designed for different VF levels, which are distributed across the chip. At runtime, depending on application profile, we combine these VF optimized routers to form constantly changing energy efficient NoC fabric. We call our architecture Malleable NoC. In this paper, we describe the architectural details of the proposed architecture and the runtime algorithms required to dynamically adapt the NoC resources. We show that for a variety of multi program benchmarks executing on Malleable NoC, Energy Delay product (EDP) can be reduced by up to 46% for widely differing workloads. We further show the effect on EDP savings for differing amounts of dark silicon area budget.

**Download Paper (PDF; Only available from the DATE venue WiFi)**
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### 9.4 Advanced Trends in Alternative Technologies

**Date:** Thursday 12 March 2015  
**Time:** 08:30 - 10:00  
**Location / Room:** Chartreuse

**Chair:** Martin Trefzer, University of York, GB  
**Co-Chair:** Yvain Thonnart, CEA-Leti, FR

As technology evolves, “information” is no longer limited to charge-based representations of 1s and 0s. In this session, the first presented paper discusses work where qubits are stored as the internal states of an atomic ion. The second presentation considers labs on chip — where reactants are moved through valves and channels to solve problems such as protein analysis, disease diagnosis, etc. Finally, the last presentation discusses the use of optical waveguides to move data from point-to-point, thus eliminating higher latency electrical interconnect.

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<tr>
<td>08:30</td>
<td>9.4.1</td>
<td><strong>OPTIMIZATION OF QUANTUM COMPUTER ARCHITECTURE USING A RESOURCE-PERFORMANCE SIMULATOR</strong></td>
<td>Muhammad Ahsan and Jungsang Kim, Duke University, US</td>
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<td>** Speakers:** Muhammad Ahsan and Jungsang Kim, Duke University, US</td>
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<td><strong>Abstract</strong></td>
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<td>The hardware technology characterized by the device parameters often drives the architectural optimization in a novel computer design such as the quantum computer (QC). We highlight the role of these parameters, by quantifying the performance of a fully error-corrected 1024-bit quantum carry look-ahead adder on a modular, re-configurable architecture based on trapped ions. We develop a simulation tool that estimates the performance and resource requirements for running a quantum circuit on various quantum architectures as a function of the underlying device parameters. Using this tool, we found that (1) the latency of the adder circuit execution due to slow entanglement generation process for qubit communication, can be adequately eliminated with a small increase in entangling qubits and (2) the failure probability of the circuit is ultimately determined by the qubit coherence time, which needs to be improved in order to reliably execute the adders comprising core of the Shor’s algorithm.</td>
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<td>09:00</td>
<td>9.4.2</td>
<td><strong>VOLUME-ORIENTED SAMPLE PREPARATION FOR REACTANT MINIMIZATION ON FLOW-BASED MICROFLUIDIC BIOCHIPS WITH MULTI-SEGMENT MIXERS</strong></td>
<td>Chi-Mei Huang¹, Chia-Hung Liu² and Juinn-Dar Huang¹</td>
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<td><strong>Speakers:</strong> Chi-Mei Huang¹, Chia-Hung Liu² and Juinn-Dar Huang¹</td>
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<td><strong>Abstract</strong></td>
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<td>Sample preparation is one of essential processes in most biochemical reactions. In this process, raw reactants are diluted to achieve given target concentrations. So far, most of existing sample preparation techniques only consider mixing of two source solutions under the (1:1) mixing model. In this paper, we propose the first sample preparation algorithm VOSPA that not only blends several solutions in a dilution operation but also allows various mixing models on flow-based microfluidic biochips with multi-segment mixers. VOSPA is a volume-oriented sample preparation algorithm that enables segment-based intermediate solution reuse for better reactant minimization. Experimental results show that VOSPA can lower the reactant consumption and operation count by 72% and 59% as compared to the baseline bit-scanning method if an 8-segment mixer is used. Moreover, VOSPA outperforms an optimal algorithm, which merely allows the use of (1:1) mixing model; the reactant usage and operation count can be further reduced by 37% and 76%.</td>
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The third paper presents a method to extend Design Space Exploration (DSE) of systems with Out-of-Order execution by accurately predicting the performance of CPUs with different cache configurations within reasonable time.

This work is motivated by the demand of an electronic design automation (EDA) approach for the emerging ecosystem of the photonic integrated circuit (PIC) technology. A reliable physical verification flow cannot be achieved without the adaption of the traditional EDA tools to the photonic design verification needs.

This paper proposes an approach to automatically identifying the topological order of smart cells in modular batteries. Emerging smart cell architectures enable battery management without centralized control by coordination of activities via communication. When connecting smart cells in series to form a battery pack, the topological order of the cells is not known and it cannot be automatically identified using the available communication bus. This order, however, is of particular importance for several battery management functions, including temperature control and active cell balancing which relate properties of the cells and their location. Therefore, this paper presents a methodology to automatically identify a topological order on the smart cells in a battery pack using a hybrid communication approach, involving both the communication and the balancing layer of the smart cell architecture. A prototypic implementation on a development platform shows the feasibility and scalability of the approach.

This paper analyzes how layout versus schematic (LVS) checking is performed differently for photonic designs, and proposes an LVS flow that addresses the particular technology. A reliable physical verification flow cannot be achieved without the adaption of the traditional EDA tools to the photonic design verification needs. We analyze how layout versus schematic (LVS) checking is performed differently for photonic designs, and propose an LVS flow that addresses the particular need of curvilinear feature validation (curved path length and bend curvature extraction). We show that it is possible to reuse and extend the current LVS tools to perform such critical but non-traditional checks, which ensures a more reliable photonic layout implementation in term of functionality and circuit yield. Going forward, we propose possible future studies that can further improve the flows.
**FP-SCHEDULING FOR MODE-CONTROLLED DATAFLOW: A CASE STUDY**

**Speakers:**
Alok Lele, Orlando Moreira, and Kees van Berkel

**Authors:**
Alok Lele, Orlando Moreira, and Kees van Berkel

**Abstract**
Dual-Radio Simultaneous Access (DRSA) is an emerging topic in Software Defined Radio (SDR) in which two SDRs are running simultaneously on a shared hardware, typically a heterogeneous Multi-Processor System-on-Chip (MPSoC). Each SDR has an independent hard latency and/or throughput requirement and needs rigorous timing analysis. Moreover, SDRs are often modeled in enriched variants of dataflow to accommodate the growing dynamic execution of SDRs, making it a challenge to perform timing analysis on them. This paper considers the preemptive Fixed Priority Scheduling (FPS) of SDRs modeled in a DRSA design example under various architecture configurations. Results show that our models predict average power consumption to within 1% and cycle-by-cycle power dissipation to within 10% of a commercial-grade level power estimation tool, all while running several orders of magnitude faster.

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**FAST AND PRECISE CACHE PERFORMANCE ESTIMATION FOR OUT-OF-ORDER EXECUTION**

**Speakers:**
Roeland Douma, Sebastian Altmeier, and Andy Pimentel

**Authors:**
Roeland Douma, Sebastian Altmeier, and Andy Pimentel

**Abstract**
Design space exploration (DSE) is a key ingredient of system-level design, enabling designers to quickly prune the set of possible designs and determine, e.g., the number of the processing cores, the mapping of application tasks to cores, and the core configuration such as the cache organization. High-level performance estimation is a principle component of any system-level DSE: it has to be fast and sufficiently precise. Modern out-of-order architectures with caches pose a significant problem to this performance estimation process, as no simple one-to-one mapping of the number of cache misses and resulting cycle time exists. We present a high-level cache performance-estimation framework for out-of-order processors. Evaluation shows that our prediction method is on average 15 times faster than cycle-accurate simulation, while our estimates only show an average error of below 3.5%, reduce the pessimism of a naïve high-level performance estimation by around 66%, and still maintain a high fidelity. Our approach thus enables quick yet accurate performance estimation and extends the applicability of system-level DSE to out-of-order processors with caches.

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**A CALIBRATION BASED THERMAL MODELING TECHNIQUE FOR COMPLEX MULTICORE SYSTEMS**

**Speakers:**
Devendra Rai and Lothar Thiele

**Authors:**
Devendra Rai and Lothar Thiele

**Abstract**
A calibration based method to construct fast and accurate thermal models of the state-of-the-art multicore systems is presented. Such models are usually required during Design Space Exploration (DSE) exercises to evaluate various task-to-core mapping, associated scheduling and processor speed-scaling options for their overall impact on the system temperature. Current approaches require modeling the thermal characteristics of the target processor using numerical simulators, which assume accurate information about several critical parameters (e.g., the processor floorplan). Such parameters are not readily available, forcing the system designers to use time and cost intensive, and possibly error-prone techniques such as using heat maps for reverse-engineering such parameters. Additionally, advanced power and temperature management algorithms commonly found in the state-of-the-art processors must also be accurately modeled. This paper proposes a calibration based method for constructing the complete system thermal model of a target processor without requiring any hard-to-get information such as the detailed processor floorplan or system power traces. Taking an example of a sufficiently complex Intel Xeon processor, we show that our approach yields an accurate thermal model, which is also lightweight both in terms of memory and compute requirements to be practically feasible for DSE over current processors.

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**DYNAMIC POWER AND PERFORMANCE BACK-ANNOTATION FOR FAST AND Accurate Functional Hardware Simulation**

**Speakers:**
Dongwook Lee, Lizy Kurian John, and Andreas Gerstlauer

**Authors:**
Dongwook Lee, Lizy Kurian John, and Andreas Gerstlauer

**Abstract**
Virtual platform prototypes are widely used for early design space exploration at the system level. There is, however, a lack of accurate and fast power and performance models of hardware components at such high levels of abstraction. In this paper, we present an approach that extends fast functional hardware models with the ability to produce detailed, cycle-level timing and power estimates. Our approach is based on back-annotating behavioral hardware descriptions with a dynamic power and performance model that allows capturing cycle-accurate and data-dependent activity without a significant loss in simulation speed. By integrating with existing high-level synthesis (HLS) flows, back-annotation is fully automated for custom hardware synthesized by HLS. We further leverage state-of-the-art machine learning techniques to synthesize abstract power models, where we introduce a structural decomposition technique to reduce model complexities and increase estimation accuracy. We have applied our back-annotation approach to several industrial-strength design examples under various architecture configurations. Results show that our models predict average power consumption to within 1% and cycle-by-cycle power dissipation to within 10% of a commercial-grade level power estimation tool, all while running several orders of magnitude faster.

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End of session
Coffee Break in Exhibition Area
Coffee Break in Exhibition Area

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Lunch Break

On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Ecrins (for fully registered conference delegates only).

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Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

9.6 Design, Synthesis and Validation of Analog Circuits

Date: Thursday 12 March 2015
Time: 08:30 - 10:00
Location / Room: Bayard

Chair: Marie-Minerve Louerat, LIP6/CNRS, FR
Co-Chair: Georges Gielen, ESAT - KU Leuven, BE

The session presents new synthesis and validation approaches to analog circuit design. Two design papers sheds new light on Tunnel FETs and an ADC.

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<tr>
<td>08:30</td>
<td>9.6.1</td>
<td>KNOWLEDGE-INTENSIVE, CAUSAL REASONING FOR ANALOG CIRCUIT TOPOLOGY SYNTHESIS IN EMERGENT AND INNOVATIVE APPLICATIONS</td>
<td>Alex Doboli, Fanshu Jiao and Sergio Montano, State University of New York at Stony Brook, US</td>
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Abstract
Analog circuit topology design has been difficult to automate. Topology synthesis involves searching an open-ended, widely extensible, and strongly discontinuous solution space. Existing algorithms cannot generate topologies beyond a constrained set of structures, or experience difficulties in evolving performance-effective yet minimal circuits. This paper proposes a new topology synthesis method that implements a design knowledge-intensive reasoning process to create novel circuit structures with all their features justified by the problem requirements. Two synthesis experiments demonstrate the capability of the method to generate circuits beyond the capabilities of existing topology synthesis algorithms.

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<td>09:00</td>
<td>9.6.2</td>
<td>A CNN-INSPIRED MIXED SIGNAL PROCESSOR BASED ON TUNNEL TRANSISTORS</td>
<td>Behnam Sedighi, Indranil Palit, Xiaobo Sharon Hu and Michael Niemier, University of Notre Dame, US</td>
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Abstract
Novel devices are under investigation to extend the performance scaling trends that have long been associated with Moore's Law-based device scaling. Among the emerging devices being studied, tunnel FETs (or TFETs) are particularly attractive, especially when targeting low power systems. This paper studies the potential of analog/mixed-signal information processing using TFETs. The design of a highly-parallel processor -- inspired by cellular neural networks -- is presented. Signal processing is performed partially in the time-domain to better leverage the unique properties of TFETs, i.e., (i) steep slopes (high g_m/I_DS) in the subthreshold region, and (ii) high output resistance in the saturation region. Assuming an InAs TFET with feature sizes comparable to the 14 nm technology node, a power efficiency of at least 10,000 GOPS/W is projected. By comparison, state-of-the-art hardware assuming CMOS/FinFET technology promises a power efficiency only close to 1000 GOPS/W.

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10:00 9.6.4 AGEING SIMULATION OF ANALOGUE CIRCUITS AND SYSTEMS USING ADAPTIVE TRANSIENT EVALUATION

Speakers:
Felix Salfelder and Lars Hedrich, Goethe-Universitat Frankfurt a. M., DE

Abstract
Simulating ageing effects in analogue circuits requires both ageing models and a circuit simulator which is capable of a stress dependent, ageing and recovery-aware model evaluation during long term transient simulation. Common approaches on reliability simulation often involve aged models, age precomputation, or lookup tables instead of integrated ageing simulation using memory-aware ageing models. Long term transient simulation enhances reliability simulation. This paper presents a framework to model and simulate ageing effects using an adaptive two-times evaluation scheme. This integrates full ageing effect models into behavioural device models. In addition, we introduce semantics for modelling stress levels and ageing parameters in hardware description languages. Our approach is a fully integrated simulation solution, enabling correct and efficient simulation of ageing systems over their lifetimes. We demonstrate how transistor level ageing effects critically affect the operation of a circuit. Our examples incorporate ageing monitors, redundant parts, and self-repair functionality into analogue systems.

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10:01 9.6.5 A TOOL FOR THE ASSISTED DESIGN OF CHARGE REDISTRIBUTION SAR ADCS

Speakers:
Stefano Brenna 1, Andrea Bonetti 2, Andrea Bonfanti 2 and Andrea L. Lacaita 2
1Politecnico di Milano, IT; 2École Polytechnique Fédérale de Lausanne (EPFL), CH

Abstract
The optimal design of SAR ADCs requires the accurate estimate of nonlinearity and parasitic effects in the feedback charge-redistribution DAC. Since the effects of both mismatch and stray capacitances depend on the specific array topology, complex calculations, custom modeling and heavy simulations in common circuit design environments are often required. This paper presents a MATLAB-based numerical tool to assist the design of the charge redistribution DACs adopted in SAR ADCs. The tool performs both parametric and statistical simulations taking into account capacitive mismatch and parasitic capacitances thus computing both differential and integral nonlinearity (DNL, INL), SINR, ENOB degradation due to static non-linear effects is also estimated. An excellent agreement is obtained with the results of circuit simulators (e.g. Cadence Spectre) featuring up to 104 shorter simulation time, allowing statistical analyses of large Monte Carlo samples to be accomplished. The tool assists the designer in the optimal array and DAC design with respect to the statistic of the mismatch and parasitic effects.

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10:02 9.6.6 DETECTION OF ASYMMETRIC AGING-CRITICAL VOLTAGE CONDITIONS IN ANALOG POWER-DOWN MODE

Speakers:
Michael Zwerger and Helmut Graeb, Technische Universitaet Muenchen, DE

Abstract
In this work, a new verification method for the power-down mode of analog circuit blocks is presented. In power-down mode, matched transistors can be stressed with asymmetric voltages. This will cause time-dependent mismatch due to transistor aging. In order to avoid reliability problems, a new method for automatic detection of asymmetric power-down stress conditions is presented. Therefore, power-down voltage-matching rules are formulated. The method combines structural analysis and voltage propagation. Experimental results demonstrate the efficiency and effectiveness of the approach.

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10:03 9.6.7 HIGH PERFORMANCE SINGLE SUPPLY CMOS INVERTER LEVEL UP SHIFTER FOR MULTI-SUPPLY VOLTAGES DOMAINS

Speakers:
José-C. García 1, Juan A. Montiel-Nelson 1, J. Sosa 2 and Saeid Nooshabadi 2
1Institute for Applied Microelectronics, ES; 2Department of Electrical and Computer Engineering of Michigan Technological University, US

Abstract
A single supply CMOS inverter level shifter (ssq-Ish) for upconverting signals from 0.4V-1.5V logic level range up to 1.1V power supply domain is introduced. For guaranteeing a low energy consumption, the proposed shifter is based on topological modifications of the structure used in literature. For 0.5V input square wave switching at 500MHz, the inverter level shifter ssq-Ish using 1.2V of power supply achieves a 60% of Figure of Merit improvement in comparison against the state-of-the-art for a dual power supply voltage of 0.6V and 1.2V. Post-layout simulation results show that ssq-Ish reaches a propagation delay of 0.75ns, an energy consumption of only 2.3pJ, and an energy-delay product of 1.73pJns for a capacitive loading condition of 950fF.

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9.7 Test Generation, Fault Simulation and Diagnosis

Date: Thursday 12 March 2015
Time: 08:30 - 10:00
Location / Room: Les Bans

Chair: Jacob Abraham, The University of Texas at Austin, US
Co-Chair: Bernd Becker, University Freiburg, DE

Speeding-up the test process is crucial from a technical and economical point of view. Novel methods are presented to accelerate silicon debug, fault simulation, test generation and diagnosis.

08:30 9.7.1 QUICK ERROR DETECTION TESTS WITH FAST RUNTIMES FOR EFFECTIVE POST-SILICON VALIDATION AND DEBUG
Speakers: David Lin¹, Eswaran S², Sharad Kumar², Eric Rentschler³ and Subhasish Mitra¹
¹Stanford University, US; ²Freescale Semiconductor, IN; ³Advanced Micro Devices, US

Abstract
Long error detection latency, the time elapsed from the occurrence of an error caused by a bug to its manifestation as an observable failure, severely limits the effectiveness of existing post-silicon validation and debug techniques. Traditional post-silicon validation tests can incur very long error detection latencies of millions or even billions of clock cycles. An earlier technique called Quick Error Detection (QED) shortens error detection latencies to only few hundred (or thousand) clock cycles. However, software-only QED (i.e., QED implemented entirely in software) can result in significantly increased post-silicon validation test runtimes. We present a new technique called Fast QED that overcomes this drawback of software-only QED, while preserving the error detection latency and bug coverage benefits of software-only QED. Simulation results using an OpenSPARC T2-like multi-core SoC and bugs abstracted from multiple commercial multi-core SoCs demonstrate: 1. Fast QED achieves 4 orders of magnitude improvement in test runtime as compared to software-only QED, with only 0.4% increase in chip area; 2. Fast QED improves error detection latencies by up to 5 orders of magnitude compared to non-QED tests, and also achieves improved error detection latencies compared to software-only QED; and, 3. Fast QED improves bug coverage by up to 2-fold compared to non-QED tests (similar to software-only QED).

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09:00 9.7.2 GPU-ACCELERATED SMALL DELAY FAULT SIMULATION
Speakers: Eric Schneider¹, Stefan Holst², Michael Kochte¹, Xiaqing Wen² and Hans-Joachim Wunderlich¹
¹University of Stuttgart, DE; ²Kyushu Institute of Technology, JP

Abstract
The simulation of delay faults is an essential task in design validation and reliability assessment of circuits. Due to the high sensitivity of current nano-scale designs against smallest delay deviations, small delay faults recently became the focus of test research. Because of the subtle delay impact, traditional fault simulation approaches based on abstract timing models are not sufficient for representing small delay faults. Hence, timing accurate simulation approaches have to be utilized, which quickly become inapplicable for larger designs due to high computational requirements. In this work we present a waveform-accurate approach for fast high-throughput small delay fault simulation on Graphics Processing Units (GPUs). By exploiting parallelism from gates, faults and patterns, the proposed approach enables accurate exhaustive small delay fault simulation even for multi-million gate designs without fault dropping for the first time.

Download Paper (PDF; Only available from the DATE venue WiFi)
09:00 IP4-18, 1031
EXPLORING THE IMPACT OF FUNCTIONAL TEST PROGRAMS RE-USED FOR POWER-AWARE TESTING
Speakers: Aymen Touati 1, Alberto Bosio 2, Luigi Dillio 2, Patrick Girard 2, Arnaud Virazel 1, Paolo Bernardi 3 and Mateo Sonza Reorda 3
1LIRMM, FR; 2LIRMUM2-CNRS, FR; 3Politecnico di Torino, IT
Abstract
Software-based self-test (SBST) techniques are used to test processors against permanent faults introduced by the manufacturing process (often as a complementary approach with respect to DFT) or to perform in-field test in safety-critical applications. A major obstacle to their adoption is the high cost for developing effective test programs, since there is still a lack of suitable EDA algorithms and tools able to automatically generate SBST test programs. An efficient ATPG algorithm can serve as the foundation for the automatic generation of SBST test programs. In this work we first highlight the additional constraints characterizing SBST test programs wrt functional ones, with special emphasis on their usage for in-field test; then, we describe an ATPG framework targeting stuck-at faults based on Bounded Model Checking. The framework allows the user to flexibly specify the requirements of SBST test programs in the considered scenario. Finally, we demonstrate how a set of properly chosen requirements can be used to generate test programs matching these constraints. In our experiments we evaluate the framework with the miniMIPS microprocessor. The results show that the proposed method is the first able to automatically generate SBST test programs whose fault efficiency is superior to those produced with state-of-the-art manual approaches.
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09:05 IP4-20, 602
FAULT DIAGNOSIS IN DESIGNS WITH EXTREME LOW PIN TEST DATA COMPRESSORS
Speakers: Subhadip Kundu 1, Parthajit Bhattacharya 2 and Rohit Kapur 3
1Synopsys India, IN; 2Synopsys Inc., US
Abstract
Diagnosis plays an important role to ramp up yield during IC manufacturing process. Limited observability due to test response compaction negatively affects the diagnosis procedure. With modern compressors - targeting very high test data compression, diagnosis becomes even more complicated. In this paper, a complete diagnosis methodology focussing on a novel mapping algorithm has been described. The mapping algorithm maps failures from compressor pins to scan cells with great accuracy (even in presence of don’t cares in the responses), so that, normal scan diagnosis can be used to find out the actual defects. Experimental results on different industrial designs have proved that the proposed method almost match scan based diagnosis results.
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09:10 IP4-21, 573
OPTIMIZING DYNAMIC TRACE SIGNAL SELECTION USING MACHINE LEARNING AND LINEAR PROGRAMMING
Speakers: Charlie Shucheng Zhu and Sharad Malik, Princeton University, US
Abstract
The success of post-silicon validation is limited by the low observability of the signals on the chip under debug. Trace buffers are used to enhance visibility of different cores in a multi-core processor environment. To increase the speed and accuracy of fault simulation, compared with previous methods, a mixed level fault reasoning approach is developed, were the fan-out re-convergence is handled on the higher FFR network level, and the fault simulation inside of FFRs relies on the gate-level information. To allow a uniform and seamless fault reasoning, Structurally Synthesized BDDs (SSBDD) are used for modeling on both levels. Experimental research demonstrated very promising results in increasing the speed and scalability of the method.
Download Paper (PDF; Only available from the DATE venue WiFi)
**Abstract**

Monolithic three-dimensional (3D) integration enables revolutionary digital system architectures of computation immersed in memory. Vertically-stacked layers of logic circuits and memories, with nano-scale inter-layer vias (with the same pitch and dimensions as tight-pitched metal layer vias), provide massive connectivity between the layers. The nano-scale inter-layer vias are orders of magnitude denser than conventional through silicon vias (TSVs). Such digital system architectures can achieve significant performance and energy efficiency benefits compared to today’s designs. The massive vertical connectivity makes such architectures particularly attractive for abundant-data applications that impose stringent requirements with respect to low-latency data processing, high-bandwidth data transfer, and energy-efficient storage of massive amounts of data. We present an overview of our progress toward realizing monolithic 3D ICs, enabled by recent advances in emerging nanotechnologies such as carbon nanotube field-effect transistors and emerging memory technologies such as Resistive RAMs and Spin-Transfer Torque RAMs.

### 9.8 Hot Topic - Monolithic 3D: A Path to Real 3D Integrated Chips

**Date:** Thursday 12 March 2015  
**Time:** 08:30 - 10:00  
**Location / Room:** Salle Lesdiguières

**Organisers:**  
Giovanni De Micheli, École Polytechnique Fédérale de Lausanne (EPFL), CH  
Pierre-Emmanuel Gaillardon, École Polytechnique Fédérale de Lausanne (EPFL), CH

**Chair:**  
Giovanni De Micheli, École Polytechnique Fédérale de Lausanne (EPFL), CH

**Co-Chair:**  
Ian O’Connor, Institut des Nanotechnologies de Lyon, FR

As compared to standard 3D technologies, 3D Monolithic Integration (3DMI) overcomes the vertical connectivity challenge through the use of nano-scale inter-layer vias, which are orders-of-magnitude smaller than TSVs. In this hot topic session, we cover 3DMI for actual (FDSOI) and emerging (CNFETs and RRAM) technologies, and identify its promises from a design perspective.

<table>
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<th>Time</th>
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<th>Presentation Title</th>
<th>Authors</th>
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</table>
| 08:30   | 9.8.1 | **A COMPREHENSIVE STUDY OF MONOLITHIC 3D CELL ON CELL DESIGN USING COMMERCIAL 2D TOOL** | Olivier Billoint,  
Hossam Sarhan,  
Iyad Rayane,  
Maud Vinet,  
Perrine Batude,  
Claire Fenouillet-Beranger,  
Olivier Rozeau,  
Gérald Cibrario,  
Fabien Deprat,  
Aurélien Fustier,  
Jean-Eric Michallet,  
Olivier Faynot,  
Ogun Turkylilmaz,  
Jean-Frederic Christmann,  
Sébastien Thuries  
and Fabien Clermidy  
1CEA LETI, FR;  
2Mentor, FR |

Abstract  
In this paper we present a methodology allowing an emulated-3D two tiers physical implementation of any design using 2D commercial tools. Place and Route is achieved through similar steps as required by 2D designs: pre clock tree synthesis (including placement), clock tree synthesis and routing; to which we added a folding step in order to emulate the 3D placement. Routing of both tiers in parallel using inter-tier metal layers is made possible by modifying input files of the tools. Our study covers power supply network on both tiers, forbidden inter-tier via on active placement and inter-tier back end flavors in order to refine quality of results. Benchmark results on two tiers 3D Monolithic integration have been done on several IPs (microcontroller, reconfigurable FFT and LDPC) using as reference ST 28nm FDSOI technology and show the correlation between cell density, routing congestion, wire length, operating frequency and power consumption. To our knowledge, this paper is the first one to evaluate monolithic 3D physical implementation using full 3D Back End description and taking into account power supply distribution on both tiers.

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<th>Authors</th>
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| 09:00   | 9.8.2 | **MONOLITHIC 3D INTEGRATION: A PATH FROM CONCEPT TO REALITY**                      | Max M. Shulaker,  
Tony F. Wu,  
Mohamed M. Sabry,  
Hai Wei,  
H.-S. Philip Wong  
and Subhasish Mitra, Stanford University, US |

Abstract  
Monolithic three-dimensional (3D) integration enables revolutionary digital system architectures of computation immersed in memory. Vertically-stacked layers of logic circuits and memories, with nano-scale inter-layer vias (with the same pitch and dimensions as tight-pitched metal layer vias), provide massive connectivity between the layers. The nano-scale inter-layer vias are orders of magnitude denser than conventional through silicon vias (TSVs). Such digital system architectures can achieve significant performance and energy efficiency benefits compared to today’s designs. The massive vertical connectivity makes such architectures particularly attractive for abundant-data applications that impose stringent requirements with respect to low-latency data processing, high-bandwidth data transfer, and energy-efficient storage of massive amounts of data. We present an overview of our progress toward realizing monolithic 3D ICs, enabled by recent advances in emerging nanotechnologies such as carbon nanotube field-effect transistors and emerging memory technologies such as Resistive RAMs and Spin-Transfer Torque RAMs.

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Presentations session the award ‘Best IP of the Day’ is given.

briefly introduced in a one-minute presentation in a corresponding regular session, prior to the actual Interactive Presentation. At the end of each afternoon Interactive Presentations run simultaneously during a 30-minute slot. A poster associated to the IP paper is on display throughout the morning. Additionally, each IP paper is

Location / Room:

Time:

Date:

IP4 Interactive Presentations

Date: Thursday 12 March 2015

Time: 10:00 - 10:30

Location / Room: Exhibition Area

Interactive Presentations run simultaneously during a 30-minute slot. A poster associated to the IP paper is on display throughout the morning. Additionally, each IP paper is briefly introduced in a one-minute presentation in a corresponding regular session, prior to the actual Interactive Presentation. At the end of each afternoon Interactive Presentations session the award ‘Best IP of the Day’ is given.

Label| Presentation Title| Authors
---|---|---

**IP4-1** | PWL: A PROGRESSIVE WEAR LEVELING TO MINIMIZE DATA MIGRATION OVERHEADS FOR NAND FLASH DEVICES | Fu-Hsin Chen¹, Ming-Chang Yang², Yuan-Hao Chang³ and Tei-Wei Kuo⁴

¹Department of Computer Science and Information Engineering, National Taiwan University, TW; ²Graduate Institute of Networking and Multimedia, National Taiwan University, TW; ³Institute of Information Science, Academia Sinica, TW; ⁴Academia Sinica & National Taiwan University, TW

**Abstract**

As the endurance of flash memory keeps deteriorating, exploiting wear leveling techniques to improve the lifetime/endurance of flash memory has become a critical issue in the design of flash storage devices. In contrast to existing wear-leveling techniques that aggressively distributes the erases to all flash blocks by a fixed threshold, we propose a progressive wear leveling design to perform wear leveling in a "progressive" way to prevent any block from being worn out prematurely, and thereby to ultimately minimize the performance overheads caused by the unnecessary data migration. The results reveal that, instead of sacrificing the device lifetime, performing wear leveling in such a progressive way can not only minimize the performance overheads but even have potentials to extend the device lifespan.

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**IP4-2** | TOWARDS TRUSTABLE STORAGE USING SSDS WITH PROPRIETARY FTL | Xiaotong Cui¹, Minhui Zou¹, Liang Shi² and Kaijie Wu³

¹Chongqing University, CN; ²College of Computer Science, Chongqing University, CN

**Abstract**

In recent years, we have seen an increasing deployment of flash-based storage, such as SSD, in mission-critical applications due to its fast read/write speed, small form factor, strong shock resistance, and etc. SSD uses a host interface and a middle layer called flash translation layer (FTL) to maintain the compatibility with the traditional magnetic-based HDD. Unlike the traditional HDD where the host OS has the full control on where to access the data, SSD uses FTL to translate and implement all operations, and OS has no such control. Even worse, FTL, which is considered as one of most important intellectual property of SSD, is often proprietary. This brings up a security concern on design trustworthiness: what if the manufacturer either accidentally or intentionally implement those operations incorrectly or even maliciously? In this paper we analyze the possible threats and propose a simple yet effective countermeasure.

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**IP4-3**

**USER-SPECIFIC SKIN TEMPERATURE-AWARE DVFS FOR SMARTPHONES**

**Speakers:**
Begum Birsen Eglımez1, Gokhan Memik1, Seda Ogrenci-Memik1 and Oğuz Ergin2

1Northwestern University, US; 2TOBB University of Economics and Technology, TR

**Abstract**
Skin temperature of mobile devices intimately affects the user experience. Power management schemes built into smartphones can lead to quickly crossing a user’s tolerance threshold on modifiable skin temperature. Furthermore, there is a significant variation among users in terms of their sensitivity. Hence, controlling the skin temperature as part of the device’s power management scheme is paramount. To achieve this, we first present a method for estimating skin and screen temperature at run-time using a combination of available on-device thermal sensors and performance indicators. In an Android-based smartphone, we achieve 99.05% and 99.14% accuracy in estimations of back cover and screen temperatures, respectively. Leveraging this run-time predictor, we develop User-specific Skin Temperature-Aware (USTA) DVFS mechanism to control the skin temperature. Performance of USTA is tested both with benchmarks and user tests comparing USTA to the standard Android governor. The results show that more users prefer to use USTA as opposed to the default DVFS mechanism.

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**IP4-4**

**FORMAL PROBABILISTIC ANALYSIS OF DISTRIBUTED DYNAMIC THERMAL MANAGEMENT**

**Speaker:**
Muhammad Shaﬁque, Karlsruhe Institute of Technology (KIT), DE

**Authors:**
Shafaq İzdeğer1, Osman Hasan2, Muhammad Shaﬁque1 and Joerg Henkel1

1National University of Sciences and Technology (NUST), Islamabad, PK; 2National University of Sciences and Technology (NUST), Islamabad;
3Karlsruhe Institute of Technology (KIT), DE

**Abstract**
The prevalence of Dynamic Thermal Management (DTM) schemes coupled with demands for high reliability motivates the rigorous veriﬁcation and testing of these schemes before deployment. Conventionally, these schemes are analyzed using either simulations or by running on real systems. But these traditional analysis techniques cannot exhaustively validate the distributed DTM schemes and thus compromise on the accuracy of the analysis results. Moreover, the randomness due to task assignments, task completion times and re-mappings, is often ignored in the analysis of distributed DTM schemes. We propose to overcome both of these limitations by using probabilistic model checking, which is a formal method for modeling and verifying concurrent systems with randomized behaviors. This paper presents a case study on the formal veriﬁcation of a state–eolute–art distributed DTM scheme using the PRISM model checker.

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**IP4-5**

**A HYBRID QUASI MONTE CARLO METHOD FOR YIELD AWARE ANALOG CIRCUIT SIZING TOOL**

**Speakers:**
Engin Afacon, Günhan Dündar, Gonenc Berkol, Ali Emre Pusane and İsmail Fakı Baskaya, Bogazici University, TR

**Abstract**
Efficient yield estimation methods are required by yield aware automatic sizing tools, where many iterative variability analyses are performed. Quasi Monte Carlo (QMC) is a popular approach, in which samples are generated more homogeneously, hence faster convergence is obtained compared to the conventional MC. However, since QMC is deterministic and has no natural variance, there is often a need to estimation variance bounds. To determine the confidence interval of the estimated yield, scrambled QMC, in which samples are randomly permuted, is run multiple times to obtain stochastic variance by sacrificing computational cost. To palliate this challenge, this paper proposes a hybrid method, where a single QMC is performed to determine infeasible solutions in terms of yield, which is followed by a few scrambled QMC analyses providing variance and confidence interval of the estimated yield. Yield optimization is performed considering the worst case of the current estimation, thus the optimizer guarantees that the solution will satisfy the confidence interval. Furthermore, a yield ranking mechanism is also developed to enforce the optimizer to search for more robust solutions.

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**IP4-6**

**FEATURE SELECTION FOR ALTERNATE TEST USING WRAPPERS: APPLICATION TO AN RF LNA CASE STUDY**

**Speakers:**
Manuel Barragán1 and Gildas Leger2

1TIMA Laboratory, FR; 2Instituto de Microelectronicas de Sevilla, IMSE-CN, (CSIC - Universidad de Sevilla), ES

**Abstract**
Testing analog, mixed-signal and RF circuits represents the main cost component for testing complex SoCs. A promising solution to alleviate this cost is the Alternate Test strategy. Alternate test is an indirect test approach that replaces costly specification measurements by simpler signatures. Machine learning techniques are then used to map signatures and performances. One key point that still remains as an open problem is the conception of adequate simple measurement candidates. This work presents efficient algorithms for selecting information rich signatures.

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**IP4-7**

**IMPROVING SIMD CODE GENERATION IN QEMU**

**Speakers:**
Sheng-Yu Fu1, Jan-Jan Wu2 and Wei-Chung Hsu1

1Department of Computer Science National Taiwan University, TW; 2Institute of Information Science Academia Sinica, TW

**Abstract**
Modern processors are often enhanced with SIMD instructions. For examples, the MMX, SSE, and AVX instruction set in the x86 architecture, and the Neon instruction set in the ARM architecture are SIMD instructions. Using these SIMD instructions could significantly increase the performance of applications, hence application binaries are likely to have a good fraction of instructions that are SIMD instructions. However, SIMD instruction translation has not attacked much attention in Dynamic Binary Translation (DBT). For example, in the popular QEMU system emulator, guest SIMD instructions are often emulated with a sequence of scalar instructions even when the host machines do have SIMD instructions to support such parallel computation, leaving a large potential for performance enhancement. In this paper, we propose two approaches, one to leverage the existing helper function implementation in QEMU, and the other to use a newly introduced vector IR (Intermediate Representation) to enhance the performance of SIMD instructions translation in DBT of QEMU. The approaches have been implemented in the QEMU to support ARM and IA32 frontends, and x86-64 backend. Our preliminary experiments show that adding vector IR can significantly enhance the performance of guest applications containing SIMD instructions for both ARM and IA32 architectures when running with QEMU on the x86-64 platform.

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**IP4-8**

**REUSE DISTANCE ANALYSIS FOR LOCALITY OPTIMIZATION IN LOOP-DOMINATED APPLICATIONS**

**Speakers:**
Christakis Lezos, Grigoris Dimitroulakos and Konstantinos Masselos, University of Peloponnese, GR

**Abstract**
This paper discusses MemAddIn, a compiler assisted dynamic code analysis tool that analyzes C code and exposes critical parts for memory related optimizations on embedded systems that can heavily affect systems performance, power and cost. The tool includes enhanced features for data reuse distance analysis and source code transformation recommendations for temporal locality optimization. Several of data reuse distance measurement algorithms have been implemented leading to different trade-offs between accuracy and profiling execution time. The proposed tool can be easily and seamlessly integrated into different software development environments offering a unified environment for application development and optimization. The novelties of our work over a similar optimization tool are also discussed. MemAddIn has been applied for the dynamic computation of data reuse distance for a number of different applications. Experimental results prove the effectiveness of the tool through the analysis and optimization of a realistic image processing application.

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IP4-9  TAPP: TEMPERATURE-AWARE APPLICATION MAPPING FOR NOC-BASED MANY-CORE PROCESSES
Speakers: Di Zhu, Lihong Chen, Timothy Pirkstein and Massoud Pedram, University of Southern California, US
Abstract
Application mapping with its ability to spread out high-power components can potentially be a good approach to mitigate the looming issue of hotspots in many-core processors. However, very few works have explored effective ways of making tradeoff between temperature and network latency. Moreover, on-chip routers, which are of high power density and may lead to hotspots, are not considered in these works. In this paper, we propose TAPP (Temperature-Aware Partitioning and Placement), an efficient application mapping algorithm to reduce on-chip hotspots while sacrificing little network performance. This algorithm "spreads" high-power cores and routers across the chip by performing hierarchical bi-partitioning of the cores and concurrently conducting placement of the cores onto tiles, and achieves high efficiency and superior scalability. Simulation results show that the proposed algorithm reduces the temperature by up to 6.80°C with minimal latency increase compared to the latency-oriented mapping solution.
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IP4-10  MALLEABLE NOC: DARK SILICON INSPIRED ADAPTABLE NETWORK ON CHIP
Speakers: Haseeb Bokhari1, Haris Javaid2, Muhammad Shafique3, Joerg Henkel1 and Sri Parameswaran1
1University of New South Wales, AU; 2Google Inc., 3Karlsruhe Institute of Technology (KIT), DE
Abstract
Network on Chip (NoC) has been envisioned as a scalable fabric for many core chips. However, NoCs can consume a considerable share of chip power. Moreover, diverse applications are executed in these multicore, where each application imposes a unique load on the NoC. To realise a NoC which is Energy and Delay efficient, we propose combining multiple VF optimized routers for each node (in traditional NoCs, we have only a single router per node) for efficient NoC for Dark Silicon chips. We present a generic NoC with routers designed for different VF levels, which are distributed across the chip. At runtime, depending on application profile, we combine these VF optimized routers to form constantly changing energy efficient NoC fabric. We call our architecture Malleable NoC. In this paper, we describe the architectural details of the proposed architecture and the runtime algorithms required to dynamically adapt the NoC resources. We show that for a variety of multi program multimedia workloads, our Malleable NoC can save up to 46% for widely differing workloads. We further show the effect on EDP savings for differing amounts of dark silicon area budget.
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IP4-11  TOPOLOGY IDENTIFICATION FOR SMART CELLS IN MODULAR BATTERIES
Speakers: Sebastian Steinhorst and Martin Lukasiewycz, TUM CREATE, SG
Abstract
This paper proposes an approach to automatically identifying the topological order of smart cells in modular batteries. Emerging smart cell architectures enable battery management without centralized control by coordination of activities via communication. When connecting smart cells in series to form a battery pack, the topological order of the cells is not known and it cannot be automatically identified using the available communication bus. This order, however, is of particular importance for several battery management functions, including temperature control and active cell balancing which relate properties of the cells and their location. Therefore, this paper presents a methodology to automatically identify a topological order on the smart cells in a battery pack by using a hybrid communication approach, involving both the communication and the balancing layer of the smart cell architecture. A prototypic implementation on a development platform shows the feasibility and scalability of the approach.
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IP4-12  LVS CHECK FOR PHOTONIC INTEGRATED CIRCUIT - CURVILINEAR FEATURE EXTRACTION AND VALIDATION
Speakers: Ruping Cao1, Julien Billoudet1, John Ferguson1, Lionel Couder2, John Cayo2, Alexandre Arriordaz1 and Ian O'Connor 3
1Mentor Graphics Corp, FR; 2Mentor Graphics Corp, US; 3Lyon Institute of Nanotechnology, FR
Abstract
This work is motivated by the demand of an electronic design automation (EDA) approach for the emerging ecosystem of the photonic integrated circuit (PIC) technology. A reliable physical verification flow cannot be achieved without the adaption of the traditional EDA tools to the photonic design verification needs. We analyze how layout versus schematic (LVS) checking is performed differently for photonic designs, and propose an LVS flow that addresses the particular need of curved path length and bend curvature extraction. We show that it is possible to reuse and extend the current LVS tools to perform such critical but non-traditional checks, which ensures a more reliable photonic layout implementation in term of functionality and circuit yield. Going forward, we propose possible future studies that can further improve the flows.
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IP4-13  FP-SCHEDULING FOR MODE-CONTROLLED DATAFLOW: A CASE STUDY
Speakers: Aljos Leit1, Orlando Moreira2 and Kees van Berkel 2
1Eindhoven University of Technology, NL; 2Ericsson B.V., NL
Abstract
Dual-Radio Simultaneous Access (DRA) is an emerging topic in Software Defined Radio (SDR) in which two SDRs are running simultaneously on a shared hardware, typically a heterogeneous Multi-Processor System-on-Chip (MPSoC). Each SDR has an independent hard latency and/or throughput requirement and needs rigorous timing analysis. Moreover, SDRs are often modeled in enriched variants of dataflow to accommodate the growing dynamic execution of SDRs, making it a challenge to perform timing analysis on them. This paper considers the preemptive Fixed Priority Scheduling (FPS) of SDRs modeled in emph (Mode-Controlled Dataflow). To the best of our knowledge this is the first time on static timing analysis of FPS for a (semi-)dynamic variant of synchronous dataflow. We propose a two-phase algorithm to determine the worst-case response time of an actor. We demonstrate our analysis results for a DRA case study of two 4G-LTE receivers.
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IP4-14  AGING SIMULATION OF ANALOGUE CIRCUITS AND SYSTEMS USING ADAPTIVE TRANSIENT EVALUATION
Speakers: Felix Salfelder and Lars Hedrich, Goethe-Universitat Frankfurt a. M., DE
Abstract
Simulating aging effects in analogue circuits requires both ageing models and a circuit simulator which is capable of a stress dependent, ageing and recovery aware model evaluation during long term transient simulation. Common approaches on reliability simulation often involve aged models, age precomputation, or lookup tables instead of integrated ageing simulation using memory aware ageing models. Long term transient ageing simulation enhances reliability simulation. This paper presents a framework to model and simulate ageing effects using an adaptive two-times evaluation scheme. This integrates full ageing effect models into behavioural device models. In addition, we introduce semantics for modelling stress levels and ageing parameters in hardware description languages. Our approach is a fully integrated simulation solution, enabling correct and efficient simulation of ageing systems over their lifetimes. We demonstrate how transistor level ageing effects critically affect the operation of a circuit. Our examples incorporate ageing monitors, redundant parts, and self-repair functionality of analogue systems.
Download Paper (PDF; Only available from the DATE venue WiFi)
[IP4-14] A TOOL FOR THE ASSISTED DESIGN OF CHARGE REDISTRIBUTION SAR ADCS
Speakers:
Stefano Brenna1, Andrea Bonetti1, Andrea Bonfanti1 and Andrea L. Lacaita1
1Politecnico di Milano, IT; 2Ecole Polytechnique Fédérale de Lausanne (EPFL), CH
Abstract
The optimal design of SAR ADCs requires the accurate estimate of nonlinearity and parasitic effects in the feedback charge-redistribution DAC. Since the effects of both mismatch and stray capacitances depend on the specific array topology, complex calculations, custom modeling and heavy simulations in common circuit design environments are often required. This paper presents a MATLAB-based numerical tool to assist the design of the charge redistribution DACs adopted in SAR ADCs. The tool performs both parametric and statistical simulations taking into account capacitive mismatch and parasitic capacitances thus computing both differential and integral nonlinearity (DNL, INL), SNDR and E\text{B}O\text{B} degradation due to static non-linear effects is also estimated. An excellent agreement is obtained with the results of circuit simulators (e.g. Cadence Spectre) featuring up to 104 shorter simulation time, allowing statistical simulations which would be otherwise impracticable. Measurements on two fabricated SAR ADCs confirm that the proposed tool can be used as valid instrument to assist the design of a charge redistribution SAR ADC and predict its static and dynamic metrics.
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[IP4-16] DETECTION OF ASYMMETRIC AGING-CRITICAL VOLTAGE CONDITIONS IN ANALOG POWER-DOWN MODE
Speakers:
Michael Zwenger and Helmut Graeb, Technische Universitat Muenchen, DE
Abstract
In this work, a new verification method for the power-down mode of analog circuit blocks is presented. In power-down mode, matched transistors can be stressed with asymmetric voltages. This will cause time-dependent mismatch due to transistor aging. In order to avoid reliability problems, a new method for automatic detection of asymmetric power-down stress conditions is presented. Therefore, power-down voltage-matching rules are formulated. The method combines structural analysis and voltage propagation. Experimental results demonstrate the efficiency and effectiveness of the approach.
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[IP4-17] HIGH PERFORMANCE SINGLE SUPPLY CMOS INVERTER LEVEL SHIFTER FOR MULTI-SUPPLY VOLTAGES DOMAINS
Speakers:
José-C. García1, Juan A. Montiel-Nelson1, J. Sosa1 and Saeid Nooshabadi2
1Institute for Applied Microelectronics, ES; 2Department of Electrical and Computer Engineering of Michigan Technological University, US
Abstract
A single supply CMOS inverter level shifter (ssqc-Is) for upconverting signals from 0.4V-1V logic level range up to 1.1V power supply domain is introduced. For guaranteeing a low energy consumption, the proposed shifter is based on topological modifications of the structure qc-level shifter reported in [1]. For 0.5V input square wave switching at 500MHz, the inverter level shifter ssqc-Is using 1.2V of power supply achieves a 60% of Figure of Merit improvement in comparison against jy-Is [8] with a dual power supply voltage of 0.6V and 1.2V. Post-layout simulation results shown that ssqc-Is reaches a propagation delay of 0.75ns, an energy consumption of only 2.3pJ, and an energy-delay product of 1.73fJps for a capacitive loading condition of 95pF.
Download Paper (PDF; Only available from the DATE venue WiFi)

[IP4-18] EXPLORING THE IMPACT OF FUNCTIONAL TEST PROGRAMS RE-USED FOR POWER-DOWN MODE
Speakers:
Aymen Touati1, Alberto Bosio2, Luigi Dilillo2, Patrick Girard2, Arnaud Virazel2, Paolo Bernardi3 and Mateo Sonza Reorda3
1LIRMM, FR; 2LIRMM-UM2/CNRS, FR; 3Politecnico di Torino, IT
Abstract
The breakpoint-based debug approach allows users to stop the normal (system) operations of the circuits under debug (CUDs), extract the internal states of the CUDs for examination, and then resume the normal operations for further debugging. However, most previous work on this approach adopts the transaction-level or handshake-level of granularity, i.e., the CUDs can be stopped only when a transaction or a handshake operation is completed. The granulations at these levels are often too coarse when a transaction or a handshake operation requires a large number of cycles to complete. In this paper, we present a novel debug mechanism, called the Protocol Agency Mechanism (PAM), which allows the breakpoint-based debug technique to be applied at the cycle-level granularity. The PAM can deal with transaction invalidation as well as protocol violation that may occur when a system is stopped and resumed. Experimental results show that it is possible to achieve a global test solution able to maximize the delay fault coverage while respecting the functional power budget. Keywords—Power Aware Test; Functional and Structural test; microprocessor test; ATPG.
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[IP4-19] A BREAKPOINT-BASED SILICON DEBUG TECHNIQUE WITH CYCLE-GRANULARITY FOR HANDSHAKE-BASED SOC
Speakers:
Hsin-Chen Chen1, Chen-Rong Wu1, Catherine Shu-Min Li1 and Kuen-Jon Lee1
1National Cheng Kung University, TW; 2National Sun Yat-sen University, TW
Abstract
The breakpoint-based silicon debug allows users to stop the normal (system) operations of the circuits under debug (CUDs), extract the internal states of the CUDs for examination, and then resume the normal operations for further debugging. However, most previous work on this approach adopts the transaction-level or handshake-level of granularity, i.e., the CUDs can be stopped only when a transaction or a handshake operation is completed. The granulations at these levels are often too coarse when a transaction or a handshake operation requires a large number of cycles to complete. In this paper, we present a novel debug mechanism, called the Protocol Agency Mechanism (PAM), which allows the breakpoint-based debug technique to be applied at the cycle-level granularity. The PAM can deal with transaction invalidation as well as protocol violation that may occur when a system is stopped and resumed. Experimental results show that the area overhead of the PAM is quite small and the performance impact on the system is negligible.
Download Paper (PDF; Only available from the DATE venue WiFi)

[IP4-20] FAULT DIAGNOSIS IN DESIGNS WITH EXTREME LOW PIN TEST DATA COMPRESSIONS
Speakers:
Subhadip Kundu1, Parthajit Bhattacharya1 and Rohit Kapur2
1Synopsys India, IN; 2Synopsys Inc., US
Abstract
Diagnosis plays an important role to ramp up yield during IC manufacturing process. Limited observability due to test response compaction negatively affects the diagnosis procedure. With modern compressors - targeting very high test data compression, diagnosis becomes even more complicated. In this paper, a complete diagnosis methodology focusing on a novel mapping algorithm has been described. The mapping algorithm maps failures from compressor pins to scan cells with great accuracy (even in presence of don’t cares in the responses), so that, normal scan diagnosis can be used to find out the actual defects. Experimental results on different industrial designs have proved that the proposed method almost match scan based diagnosis results.
Download Paper (PDF; Only available from the DATE venue WiFi)
OPTIMIZING DYNAMIC TRACE SIGNAL SELECTION USING MACHINE LEARNING AND LINEAR PROGRAMMING

Speakers: Charlie Shucheng Zhu and Sharad Malik, Princeton University, US

Abstract

The success of post-silicon validation is limited by the low observability of the signals on the chip under debug. Trace buffers are used to enhance visibility of a subset of the verification signals during the chip’s operation. These trace signals can be selected statically, i.e. the same trace signals are used through an entire debugging run, or dynamically where a different set of signals can be used in different parts of a debugging run. The focus of this work is on dynamic trace signal selection. Our technique uses machine learning for classification of different groups of inputs that are likely to trigger different faults, and a linear programming based optimization method for selecting the different sets of trace signals for different combinations of inputs and states. In contrast to existing methods, this technique is applicable to both transient and permanent faults.

Download Paper (PDF; Only available from the DATE venue WiFi)

UB09 Session 9

Date: Thursday 12 March 2015
Time: 10:00 - 12:00
Location / Room: University Booth, Booth 4, Exhibition Area

UB09.1 VDA-ADMF: AN AGILE MIGRATION FRAMEWORK FOR ANALOG LAYOUT DESIGN

Presenter: Po-Cheng Pan, National Chiao Tung University, TW
Authors: Ching-Yu Chin, Hung-Ming Chen, Tung-Chieh Chen, Jou-Chun Lin and Yi-Peng Weng

Abstract

The developed and presented revolutionary new set of tools enables complex lab-on-chip solutions in nanoscale FPGAs and it allows easy implementation of tasks like complete on-chip internal parameter measurements in FPGAs, actual structure delays with respect to environmental parameters, device and platform identification, validation of selected parameters, identification of crosstalk path and mutual impacts, as well as various changes in internal parameters. It actively supports design reconfiguration. The set of tools can be used for fast standalone or system built-in post-production device and platform parameter and quality checking and validation, parameter-aware placement and routing of critical design parts and performance optimization of existing designs, device aging identification and validation, active and online data generation for reliability assessments and design reliability enhancements. It is available for FPGAs from 90nm down and will be demonstrated on advanced 28nm Xilinx FPGAs.

More information ...

UB09.2 LINUX ON TSAR: PORTING THE LINUX KERNEL TO THE TSAR MANYCORE ARCHITECTURE

Presenter: César Fuguet Tortolero, UPMC-LIP6, FR
Authors: Joël Porquet and Alain Greiner, UPMC-LIP6, FR

Abstract

In this demonstration, we explain how we ported a Linux-based Operating System to the TSAR manycore architecture. In the associated poster, we describe the TSAR architecture and enumerate the pieces of software that usually need to be ported for a new processor architecture, and we give further details about our port. We also demonstrate this work by running Linux on a FPGA-based prototype of TSAR. The demo shows the entire boot process, from the powerup to the terminal prompt where the user can type in commands and interact with the hardware system.

More information ...

UB09.3 AN FPGA LAB-ON-CHIP: AN ANALYSIS TOOL AND FRAMEWORK FOR ADVANCED MEASUREMENTS AND RELIABILITY ASSESSMENTS ON MODERN NANOSCALE FPGAS

Presenter: Peter Pfeifer, Technical University of Liberec, CZ

Abstract

Wide portfolio of new technologies in design and manufacturing of advanced integrated circuits enables higher integration of complex structures at ultra-high nanoscale densities, but also sensitivity to various changes of the internal nanostructures and their parameters, resulting in the requirement of advanced reliability assessments. The developed and presented revolutionary new set of tools enables complex lab-on-chip solutions in nanoscale FPGAs and it allows easy implementation of tasks like complete on-chip internal parameter measurements in FPGAs, actual structure delays with respect to environmental parameters, device and platform identification, validation of selected design parameters, identification of crosstalk path and mutual impacts, as well as various changes in internal parameters. It actively supports design reconfiguration. The set of tools can be used for fast standalone or system built-in post-production device and platform parameter and quality checking and validation, parameter-aware placement and routing of critical design parts and performance optimization of existing designs, device aging identification and validation, active and online data generation for reliability assessments and design reliability enhancements. It is available for FPGAs from 90nm down and will be demonstrated on advanced 28nm Xilinx FPGAs.

More information ...

UB09.4 VDA-ADMF: AN AGILE MIGRATION FRAMEWORK FOR ANALOG LAYOUT DESIGN

Presenter: Hung-Ming Chen, National Chiao Tung University, TW
Authors: Jou-Chun Lin and Tai-Sung Chiou, National Chiao Tung University, TW

Abstract

The success of post-silicon validation is limited by the low observability of the signals on the chip under debug. Trace buffers are used to enhance visibility of a subset of the verification signals during the chip’s operation. These trace signals can be selected statically, i.e. the same trace signals are used through an entire debugging run, or dynamically where a different set of signals can be used in different parts of a debugging run. The focus of this work is on dynamic trace signal selection. Our technique uses machine learning for classification of different groups of inputs that are likely to trigger different faults, and a linear programming based optimization method for selecting the different sets of trace signals for different combinations of inputs and states. In contrast to existing methods, this technique is applicable to both transient and permanent faults.

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UB09 Session 9

Date: Thursday 12 March 2015
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Presenter: Po-Cheng Pan, National Chiao Tung University, TW
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Authors: Jou-Chun Lin and Tai-Sung Chiou, National Chiao Tung University, TW

Abstract

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Download Paper (PDF; Only available from the DATE venue WiFi)
REAL-TIME PATTERN DETECTION OF MOVEMENT RELATED POTENTIALS BY SYNCHRONIZED EEG AND EMG

Presenter: Valerio Francesco Annese, Politecnico di Bari, IT
Author: Daniela De Venuto, Politecnico di Bari, IT

Abstract
Before the conscious intention to perform any voluntary movement, our brain has already activated the action, 1s before the muscle activity actually starts. The brain processes are necessary to determine the performance of the movement itself. The presence of both the premotor potential (also called "Bereitschaftspotential" or "Readiness Potential" in the 2-5 Hz band) and the Mu-rhythm (in the 7-12 Hz) is particularly interesting for the detection of voluntary movement. Therefore, the detection of these movements' related potentials (MRPs), before the EMG activation, indicates the movement intentionality. Due to the presence of artifacts (blinking, eye movement, swallowing etc.) that spoil EEG signals, the real-time detection of MRPs is particularly challenging. In this proposal, we describe a complete wearable system performing synchronous EEG and EMG monitoring to on-line detect MRPs and prevent unintentional and dangerous movements. The Bereitschaftspotential (BP) and Mu-rhythm detection is carried out through a wavelet analysis on differential signals captured 1-second before the EMG activation. This differential approach allows discerning if the recorded EEG activity is related to the motor cortex or if it is just a common artifact. The EEG/EMG monitoring system can face the strict requirements of ambient assisted living application (AAL), taking care of aged and disable people in a domestic environment. Specifically for this application, the system can be configured as following: data from 12 EEG channels are firstly collected in a central unit that wirelessly communicates with the gateway (24 bit resolution - 500 Hz sampling rate), the gateway receives data also from each of the 8 EMG nodes (12-bit resolution, 500 Hz sampling rate). For a comfortably use, a battery life of - at least - 10 hours, have to be implemented. Moreover, a working range of 10 meters (between nodes and gateway) is considered. Above all, the requirement of wearability is achieved by the transfer printing technology, produced using photolithography and dry etch techniques, that allows the creation of wireless, tiny and lightweight electrodes for both EEG and EMG printed on bio-polymers (Polycaprolactone). Since a huge amount of retrieved data is expected, a data rate of 250 kbps (~31 kbps) is needed: a good compromise in terms of power consumption and data rate is achieved through the standard IEEE-802.15.1 (Bluetooth low energy -BLE). The gateway unit (a smartphone or a tabled) receives the EEG and EMG sensor data and performs signal analysis to identify possible MRPs patterns through wavelet analysis. In this contribute it will be delineated as case study the possible implementation in fall prevention where not only the unwanted muscle movement is detected but also a bio-feedback is activated to block the muscle and inform an assistive center. Nevertheless, the field of application of the system here presented covers a wide range of AAL applications including fall prevention, rehabilitation (i.e. walk monitoring), artificial limb control and neurodegenerative diseases diagnosis.

FUNCTIONAL ECO: AN EFFICIENT REWIRING ENHANCED FUNCTIONAL ECO

Presenter: Tak Kei Lam, The Chinese University of Hong Kong, HK
Authors: Xing Wei1, Yi Diao1, Tak Kei Lam2 and Yu-Liang Wu1
1Easy-Logic Technology Limited, HK; 2The Chinese University of Hong Kong, HK

Abstract
Circuit designs have been much more complex nowadays. Bugs and/or specification changes often happen in late design cycles. Running the whole design cycle again is time consuming and costly. Functional engineering change order (ECO), which is the process that patches an old implementation to accomplish a new specification, is therefore performed instead to save time and cost. In an ECO effort, minimizing the patch size is crucial since it gives a higher chance of successful insertion and minimal perturbation to a near or completely committed EDA outcome (e.g. satisfaction on area and timing constraints). However, an ECO work can be very difficult at this stage as the combinational signals of the old specification may have vanished after iterations of synthesis and optimizations. We implemented a practical prototype for functional ECO. Our result outperforms all results publicized in the ICCAD 2012 Contest.

3D-COSTAR: USING 3D-COSTAR FOR 2.5D-/3D-SIC COST ANALYSIS

Presenter: Mottaqiallah Taouil, TU Delft, NL
Authors: Mottaqiallah Taouil1, Said Hamdioui1 and Erik Jan Marinissen2
1TU Delft, NL; 2IMEC, BE

Abstract
Selecting an appropriate and efficient test flow for a 2.5D/3D Stacked IC (2.5D-SIC/3D-SIC) is crucial for overall cost optimization. In this demonstration, we present 3D-COSTAR, a tool that considers costs involved in the whole 2.5D/3D-SIC chain, including design, manufacturing, test, packaging and logistics, e.g. related to shipping wafers between a foundry and a test house; and provides the estimated overall cost for 2.5D/3D-SICs and its cost breakdown for a given input parameter set, e.g., test flows, die yield and stack yield. Several case studies will be presented in which the overall cost and product quality (in defective parts per million) are analyzed.

WORKCRAFT: FRAMEWORK FOR INTERPRETED GRAPHS

Presenter: Danil Sokolov, Newcastle University, GB

Abstract
Workcraft is a cross-platform framework for capture, simulation, synthesis and verification of graph models. It supports a wide range of popular graph formalisms and provides a plugin-based framework for modelling and analysis of new model types.

CRYPTOCHIP: DEMONSTRATION OF CRYPTOGRAPHIC ASIC PROTOTYPE

Presenter: Xuan Thuy Ngo, Télécom ParisTech, FR
Authors: Xuan Thuy Ngo, Jean-Luc Danger, Sylvain Guilleul, Tarik Graba, Yves Mathieu and Zakaria Najm, Télécom ParisTech, FR

Abstract
We want to demonstrate a cryptographic ASIC implemented in ST 65nm technology. It features the following IPs: Open Loop True Random Number Generator (TRNG), Loop Physical Unclonable Function (PUF), SRAM PUF, Secure Clock, Digital Sensor, Advanced Encryption Standard (AES) with Piret-Trojan. Active Shield. The demo consists in presenting the functionality and the security level of some of those IPs.
12:30 Lunch Break, Keynote lecture from 1320 - 1350 (Room Oisans) in Les Écrins

Coffee Break in Exhibition Area

On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area.

Lunch Break

On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Ecrins (for fully registered conference delegates only).

Tuesday, March 10, 2015
Coffee Break 10:30 - 11:30
Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
Coffee Break 16:00 - 17:00

Wednesday, March 11, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)
Coffee Break 16:00 - 17:00

Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

10.1 SPECIAL DAY Hot Topic: Wearable Medical Applications

Date: Thursday 12 March 2015
Time: 11:00 - 12:30
Location / Room: Salle Oisans

Organiser: Jo De Boeck, IMEC, BE
Chair: Renzo Dal Molin, Sorin Group, FR
Co-Chair: Chris Van Hoof, IMEC, BE

Wearable devices are hot. This session will treat opportunities in technology and application for devices that assist in prevention and monitoring in selected cases.

<table>
<thead>
<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>11:00</td>
<td>10.1.1</td>
<td>MOBILE HEALTH MONITORING: ADOPTION AND SYSTEM CHALLENGES</td>
<td>David Shanes, BioTelemetry, Inc., US</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Abstract</strong></td>
<td>Biotelemetry, formerly Cardioton, is leader in the advancement of mobile health monitoring by providing innovative products and services to help healthcare professionals track and diagnose patients in a more efficient, accurate, and cost-effective manner. This presentation will indicate the challenges in the adoption of innovative medical device systems including how to excite and capture customers. Also, it will address medical application considerations in electronic systems design where a unique system of requirements needs to be met including factors such as availability, dependability, ruggedness, operational environments, testing and documentation.</td>
</tr>
<tr>
<td>11:30</td>
<td>10.1.2</td>
<td>WEARABLE DEVICE FOR PHYSICAL AND EMOTIONAL HEALTH MONITORING</td>
<td>Srinivasan Murali, SmartCardia, OH</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Abstract</strong></td>
<td>Personal health monitoring systems are emerging as promising solutions to tackle health-care costs and delivery. There is a growing interest within the medical community in developing ultra-small, portable devices that can continuously monitor and process several vital body parameters, such as the Electrocardiogram (ECG) and breathing. In this talk, we will present a wearable device for physical and emotional health monitoring. The device obtains user's key physiological signals: ECG, breathing and skin conductance and derives the user's emotion states as well. We will present case studies on how the technology can improve physical and emotional health of users and the key challenges encountered during the design process.</td>
</tr>
<tr>
<td>12:00</td>
<td>10.1.3</td>
<td>GAIT ANALYSIS FOR FALL PREDICTION USING HIERARCHICAL TEXTILE-BASED CAPACITIVE SENSOR ARRAYS</td>
<td>Rebecca Baldwin, University of Maryland, Baltimore County, US</td>
</tr>
<tr>
<td></td>
<td></td>
<td><strong>Abstract</strong></td>
<td>Falls are a major cause of injuries in adults above the age of sixty-five. The economic aftermath of falls and their consequent hospitalization can be huge, totally more than 30 billion dollars in 2010 alone. A plausible way of mitigating this problem is accurate prediction of future falls and taking proactive remedial action. Spatio-temporal variation in gait is a reliable indicator of a future fall, however, existing systems focus on gait analysis in clinical settings and are not tuned towards continuous gait analysis. In this paper, we present the design of a novel textile capacitive sensor array-based system built into clothing that can reliably capture spatio-temporal gait attributes in a home setting. A key novel research contribution of our work is a context-aware hierarchical signal processing architecture that breaks down the signal processing algorithm into a hierarchy of processing elements. The lower power processing components perform generic feature extraction using observations derived from the capacitor plates, while the higher-level processors aggregate features to infer gait attributes such as stride speed and inter-leg spacing. The system activates the higher power processing elements only when it detects walking. We have prototyped our system using textile capacitive plates built into an ace-bandage and a custom FPGA-based system and show that our system can accurately detect gait attributes that have high correlation with falls, while consuming minimal energy as estimated for a multi-clock-domain 180-nm IC.</td>
</tr>
</tbody>
</table>

Download Paper (PDF; Only available from the DATE venue WiFi)
### 10.2 Emerging Memory Architectures

**Date:** Thursday 12 March 2015  
**Time:** 11:00 - 12:30  
**Location / Room:** Belle Etoile

**Chair:** Luca Perniola, CEA-Leti, FR  
**Co-Chair:** Pierre-Emmanuel Gaillardon, École Polytechnique Fédérale de Lausanne (EPFL), CH

Memories are of utmost importance in modern electronic systems. Emerging memory technologies hold a lot of promise to further integration density and performance levels, while reducing energy consumption. In this session, the first two papers introduce innovative solutions for better control of the endurance limitations of novel memories, while the last two papers investigate the gains in performance metrics from a system-level perspective.

#### 10.2.1 HRERAM: A HYBRID RECONFIGURABLE RESISTIVE RANDOM-ACCESS MEMORY

**Speakers:** Miguel Angel Lastras-Montaño, Amirali Ghofrani and Kwang-Ting Cheng, UC Santa Barbara, US

**Abstract**  
Passive crossbar arrays of memristors have been identified as excellent alternatives for future random-access memories. One limitation is their inability of selecting a memory cell without the interference caused by the sneak-path currents from other partially selected cells, as it results not only in unnecessary waste of energy but also in larger current requirements. The complementary resistive switch (CRS), consisting in two anti-serially connected memristors, is considered a potential solution to the sneak-path problem. However, the destructive read operation and reduced endurance of the CRS render it unattractive for the otherwise excellent candidate for next-generation crossbar-based non-volatile memories. In this paper we explore the feasibility and tradeoffs of configuring part of the CRS memory into a memristive mode to mitigate these limitations. The inherent locality of memory accesses for most computer programs offers an opportunity for designing a cache-like adaptive CRS-based crossbar memory with hybrid configurations of CRS and memristive modes, enabling optimization for both endurance and energy consumption. Our simulation results validate that the proposed hybrid system achieves 1.5-7x reduction in energy consumption in comparison with a memristive-only memory system and significantly improves the endurance of the CRS-based memory.

[Download Paper (PDF; Only available from the DATE venue WiFi)](#)

#### 10.2.2 NCODE: LIMITING HARMFUL WRITES TOEmerging Mobile NVRAM THROUGH CODE SWAPPING

**Speakers:** Kan Zhong, Duo Liu, Linbo Long, Xiao Zhu, Weichen Liu, Qingfeng Zhuge and Edwin Sha, Chongqing University, CN

**Abstract**  
Mobile applications are becoming more and more powerful but also dependent on large main memories, which consume a large portion of system energy. Swapping to byte-addressable, non-volatile memory (NVRAM) is a promising solution to this problem. However, most NVRAMs have limited write endurance. To make it practical, the design of an NVRAM based swapping system must also consider endurance. In this paper, we target at prolonging the lifetime of NVRAM based swap area in mobile devices. Different form traditional wisdom, such as wear leveling and hot/cold data identification, we propose to build a system called nCode, which exploits the fact that code pages are easy to identify, read-only, and therefore a perfect candidate for swapping. Utilizing NVRAM's byte-addressability, we support execute-in-place (XIP) of the code pages in the swap area, without copying them back to DRAM based main memory. Experimental results based on the Google Nexus 5 smartphone show that nCode can effectively prolong the lifetime of NVRAM under various workloads.

[Download Paper (PDF; Only available from the DATE venue WiFi)](#)
## 10.2.3 12:00 SYSTEM LEVEL EXPLORATION OF A STT-MRAM BASED LEVEL 1 DATA-CACHE

**Authors:**
- Manu Komalan
- Jose Ignacio Gomez
- Christian Tenliado
- Francisco Tirado Fernandez
- Francky Cattin

**Presentation Title:** SYSTEM LEVEL EXPLORATION OF A STT-MRAM BASED LEVEL 1 DATA-CACHE

**Abstract:**
Since Non-Volatile Memory (NVM) technologies are being explored extensively nowadays as viable replacements for SRAM based memories in LLCs and even L2 caches, we try to take stock of their potential as level 1 (L1) data caches. These NVMs like Spin Torque Transfer RAM (STT-MRAM), Resistive-Ram (ReRAM) and Phase Change RAM (PRAM) are not subject to leakage problems with technology scaling. They also show significant area gains and lower dynamic power consumption. A direct drop-in replacement of SRAM by NVMs is, however, still not feasible due to a number of shortcomings, with latency (write or read) and/or endurance/reliability among them being the major issues. STT-MRAM is increasingly becoming the NVM of choice for high performance and general purpose embedded platforms due to characteristics like low access latency, low power and long lifetime. With advancements in cell technology, and taking into account the stringent reliability and performance requirements for advanced technology nodes, the major bottleneck to the use of STT-MRAM in high level caches has become read latency (instead of write latency as previously believed). The main focus of this paper is the exploration of read penalty issues in a NVM based L1 Data cache (D-cache) for an ARM like single core general purpose system. We propose a design method for the STT-MRAM based D-cache in such a platform. This design addresses the adverse effects due to the STT-MRAM read penalty issues by means of micro-architectural modifications along with code transformations. According to our simulations, the proposed modifications can effectively reduce the performance penalty introduced by the NVM (initially ~54%) to extremely tolerable levels (~8%).

Download Paper (PDF; Only available from the DATE venue WiFi)

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## 10.2.4 12:15 HIGH PERFORMANCE AXI-4.0 BASED INTERCONNECT FOR EXTENSIBLE SMART MEMORY CUBES

**Authors:**
- Erfan Azarkhish
- Igor Lii
- Davide Rossi
- Luca Benini

**Presentation Title:** HIGH PERFORMANCE AXI-4.0 BASED INTERCONNECT FOR EXTENSIBLE SMART MEMORY CUBES

**Abstract:**
The recent technological breakthrough represented by the Hybrid Memory Cube is on its way to improve bandwidth, power consumption, and density. This is while heterogeneous 3D integration has provided another opportunity for revisiting near memory computation to fill the gap between the processors and memories even further. In this paper, we take the first step towards a “Smart Memory Cube (SMC)”, a fully backward compatible and modular extension to the standard HMC, supporting near memory computation on its Logic Base (LoB), through a high performance interconnect designed for this purpose. The main feature of SMC is the high bandwidth, low latency, and AXI-4.0 compatible interconnect. This interconnect is designed to serve the huge bandwidth demand by HMC’s serial links, and to provide extra bandwidth to a processor-in-memory (PIM) embedded in the Logic Base (LoB). Our results obtained from cycle accurate simulation demonstrate that the interconnect can easily meet the demands of current and future projections of HMC (Up to 87GB/s READ bandwidth with 4 serial links and 16 memory vaults, and 175GB/s with 8 serial links and 32 memory vaults, for injected random traffic). Moreover, the interference between the PIM traffic and the main links was found to be negligible with execution time increase of less than 5%, and average memory access time increase of less than 15% when 55GB/s bandwidth is requested by the main links and 15GB/s bandwidth is delivered to the PIM port. Moreover, preliminary logic synthesis with Synopsys Design Compiler confirms that our interconnect is implementable and realistic.

Download Paper (PDF; Only available from the DATE venue WiFi)

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## 10.2.5 12:30 IPS-1 673 TOWARDS SYSTEMATIC DESIGN OF 3D PNML LAYOUTS

**Authors:**
- Robert Perricone
- Yining Zhu
- Katherine Sanders
- Sharon Hu
- Michael Niemier

**Presentation Title:** TOWARDS SYSTEMATIC DESIGN OF 3D PNML LAYOUTS

**Abstract:**
Nanomagnetic logic (NML) is a “beyond-CMOS” technology that uses bistable magnets to store, process, and move binary information. Compared to CMOS, NML has several advantages such as non-volatility, lower power consumption, and radiation hardness. Recently, NML devices with perpendicular magnetic anisotropy (pNML) have been experimentally demonstrated to perform logic operations in three dimensions. 3D pNML layouts provide additional benefits such as simplified signal routing and greater integration density. However, designing functional 3D pNML circuits can be challenging as one must consider the effects of fringing magnetic fields in three dimensions. Furthermore, the current process of designing 3D pNML layouts is little more than a trial-and-error-based approach, which is infeasible for larger, more complex designs. In this paper, we propose a systematic approach to designing 3D pNML layouts. Our design process leverages a machine learning-inspired prediction approach that examines the effects of varying individual device parameters (e.g., length, width, etc.) and predicts functional configurations.

Download Paper (PDF; Only available from the DATE venue WiFi)

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## 10.2.6 12:31 IPS-2 733 DESTINY: A TOOL FOR MODELING EMERGING 3D NVM AND EDRAM CACHES

**Authors:**
- Matt Poremba
- Sparsh Mittal
- Dong Li
- Jeffrey Vetter
- Yuan Xie

**Presentation Title:** DESTINY: A TOOL FOR MODELING EMERGING 3D NVM AND EDRAM CACHES

**Abstract:**
The continuous drive for performance and density has pushed the researchers to explore novel memory technologies (e.g. non-volatile memory) and novel fabrication approaches (e.g. 3D stacking) in the design of caches. However, a comprehensive approach which models both conventional and emerging memory technologies for both 2D and 3D designs has been lacking. We present DESTINY, a microarchitecture-level tool for modeling 3D (and 2D) cache designs using SRAM, embedded DRAM (eDRAM), spin transfer torque RAM (STT-RAM), resistive RAM (ReRAM) and phase change RAM (PCM). DESTINY facilitates design-space exploration across several dimensions, such as optimizing for a target (e.g. latency or area) for a given memory technology, choosing the suitable memory technology or fabrication method (i.e. 2D vs 3D) for a desired optimization target etc. DESTINY has been validated against industrial cache prototypes. We believe that DESTINY will drive architecture and system-level studies and will be useful for researchers and designers.

Download Paper (PDF; Only available from the DATE venue WiFi)
Tianyi Wang, Linwei Niu, Shaolei Ren and Gang Quan

West Virginia State University, US

Abstract
The rising performance variance of IC chips and increased resource sharing in multi-core platforms have significantly degraded the predictability of real-time systems. The traditional deterministic approaches can be extremely pessimistic, if not feasible at all. In this paper, we adopt a probabilistic approach for fixed-priority preemptive scheduling of real-time tasks on multi-core platforms with statistical deadline miss ratio guarantee. Rather than a single-valued worst-case execution time (WCET), we formulate the task execution time as a probabilistic distribution. We develop a novel algorithm to partition real-time tasks on multiple homogenous cores, which takes not only task execution time distributions but their period relationships into considerations. Our extensive experimental results show that our proposed methods can greatly improve the schedulability of real-time tasks when compared with the traditional bin packing approaches.

Download Paper (PDF; Only available from the DATE venue WiFi)
Lunch Break

On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Écrins (for fully registered conference delegates only).

Tuesday, March 10, 2015
Coffee Break 10:30 - 11:30
Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
Coffee Break 16:00 - 17:00

Wednesday, March 11, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)
Coffee Break 16:00 - 17:00

Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

10.4 Energy Aware Data Center: Design and Management

Date: Thursday 12 March 2015
Time: 11:00 - 12:30
Location / Room: Chartreuse

Chair: Andrea Bartolini, Università di Bologna, IT / ETH Zürich, CH
Co-Chair: Andreas Burg, École Polytechnique Fédérale de Lausanne (EPFL), CH

The session covers various topics in improving data center energy efficiency, from hardware acceleration, scheduling to cooling.

11:00 10.4.1 MEMORY FAST-FORWARD: A LOW COST SPECIAL FUNCTION UNIT TO ENHANCE ENERGY EFFICIENCY IN GPU FOR BIG DATA PROCESSING

Speakers:
Eunhyeok Park¹, Junwhan Ahn², Sungpack Hong¹, Sungjoo Yoo¹ and Sunggu Lee¹
¹POSTECH, KR; ²SNU, KR; ³Oracle, US

Abstract
Energy efficiency in big data processing is one of key issues in servers. Big data processing, e.g., graph computation and MapReduce, is characterized by massive parallelism in computation and a large amount of fine-grained random memory accesses often with structural localities due to graph-like data dependency. Recently, GPU is gaining more and more attention for servers due to its capability of parallel computation. However, the current GPU architecture is not well suited to big data workload due to the limited capability of handling a large number of memory requests. In this paper, we present a special function unit, called memory fast-forward (MFF) unit, to address this problem. Our proposed MFF unit provides two key functions. First, it supports pointer chasing which enables computation threads to issue as many memory requests as possible to increase the potential of coalescing memory requests. Second, it coalesces memory requests bound for the same cache block, often due to structural locality, thereby reducing memory traffics. Both pointer chasing and memory request coalescing contribute to reducing memory stall time as well as improving the real utilization of memory bandwidth, by removing duplicate memory traffics, thereby improving performance and energy efficiency. Our experiments with four graph computation algorithms and real graphs show that the proposed MFF unit can improve the energy efficiency of GPU in graph computation by average 54.6% at a negligible area cost.

Download Paper (PDF; Only available from the DATE venue WiFi)

11:30 10.4.2 POWER MINIMIZATION FOR DATA CENTER WITH GUARANTEED QOS

Speakers:
Shuo Liu¹, Soomar Homsi¹, Ming Fan², Shaoeli Ren¹, Gang Quan¹ and Shangping Ren²
¹Florida International University, US; ²Illinois Institute of Technology, US

Abstract
Data centers have been widely employed to offer reliable and agile on-demand web services. However, the dramatic increase of the operational cost, largely due to the power consumptions, has posed a significant challenge to the service providers as services expand in both scale and scope. In this paper, we study the problem of how to improve resource utilization and minimize power consumption in a data center with guaranteed quality-of-service (QoS). Different from a common approach that separates requests with different QoS levels on different servers, we devise an approach to pack requests of the same service --- even with different QoS requirements --- into the same server to improve resource usage. We also develop a novel method to improve the system utilization without compromising the QoS levels by removing potential failure requests. Experimental results show superiority of our approach over other widely applied approaches.

Download Paper (PDF; Only available from the DATE venue WiFi)
**ENERGY-AWARE COOLING FOR HOT-WATER COOLED SUPERCOMPUTERS**

**Speakers:**
Christian Conficoni¹, Andrea Bartolini², Andrea Tili³, Gianpietro Tecchiolli³ and Luca Benini⁴

¹Università di Bologna, IT; ²Università di Bologna, IT / ETH Zürich, CH; ³Eurotech, IT; ⁴Università di Bologna / ETH Zürich, IT

**Abstract**
Hot-water liquid cooling is a key technology in future green supercomputers as it maximizes the cooling efficiency and energy reuse. However, the cooling system still is responsible for a significant percentage of modern HPC power consumption. Standard design of liquid-cooling control relies on rules based on worst-case scenarios, or on CFD simulation of portion of the entire system, which cannot account for all the real supercomputer working conditions (workload and ambient temperature). In this work we first introduce an analytical model, based on lumped parameters, which can effectively describe the cooling components and dynamics, and can be used for analysis and control purposes. We then use it to design an energy-optimal control strategy which is capable to minimize the pump and chiller power consumption while, meeting the supercomputer cooling requirements. We validate the method with simulation tests, taking data from a real HPC cooling mechanism, and comparing the results with state-of-the-art commercial cooling system control strategies.

Download Paper (PDF; Only available from the DATE venue WiFi)

**BIG-DATA STREAMING APPLICATIONS SCHEDULING WITH ONLINE LEARNING AND CONCEPT DRIFT DETECTION**

**Speakers:**
Karim Kanoun¹ and Mihaela van der Schaar²

¹École Polytechnique Fédérale de Lausanne (EPFL), CH; ²University of California, Los Angeles, US

**Abstract**
Several techniques have been proposed to adapt Big-Data streaming applications to resource constraints. These techniques are mostly implemented at the application layer and make simplistic assumptions about the system resources and they are often agnostic to the system capabilities. Moreover, they often assume that the data streams characteristics and their processing needs are stationary, which is not true in practice. In fact, data streams are highly dynamic and may also experience concept drift, thereby requiring continuous online adaptation of the throughput and quality to each processing task. Hence, existing solutions for Big-Data streaming applications are often too conservative or too aggressive. To address these limitations, we propose an online energy-efficient scheduler which maximizes the QoS (i.e., throughput and output quality) of Big-Data streaming applications under energy and resources constraints. Our scheduler uses online adaptive reinforcement learning techniques and requires no offline information. Moreover, our scheduler is able to detect concept drifts and to smoothly adapt the scheduling strategy. Our experiments realized on a chain of tasks modeling real-life streaming application demonstrate that our scheduler is able to learn the scheduling policy and to adapt it such that it maximizes the targeted QoS given energy constraint as the Big-Data characteristics are dynamically changing.

Download Paper (PDF; Only available from the DATE venue WiFi)

**Lunch Break, Keynote lecture from 1320 - 1350 (Room Oisans) in Les Écrins**

Coffee Break in Exhibition Area

On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area.

**Lunch Break**
On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Écrins (for fully registered conference delegates only).

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Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

**Reconfigurable Architectures and Applications**

**Date:** Thursday 12 March 2015

**Location / Room:** Meije

**Chair:**
Christian Plessl, University of Paderborn, DE

**Co-Chair:**
Enno Lübbers, Intel Labs Europe, DE

Reconfigurable computing has vast potential for enhancing the performance of applications especially when using architectural optimizations. This session has two papers that focus on architectural enhancements while the third demonstrates a hardware accelerated bioinformatics application.
Abstract

As FPGAs speed, power efficiency, and logic capacity are increasing, so does the number of applications which make use of FPGA processors. However, due to placement and routing constraints, FPGA processors instruction delay balancing is a real challenge, especially when the implementation approaches the FPGA resource capacity. Consequently, even though some instructions can operate at high frequencies, the slow instructions determine the processor clock period, resulting in the underutilisation of the processor potential. However, the fast instructions latent performance may be harnessed through Adaptive Clock Management (ACM), i.e., by dynamically adapting the clock frequency such that each instruction gets sufficient time for correct completion. Up to date, ACM augmented FPGA processors have been proposed based on Clock Multiplexing (CM), but they suffer from long clock switching delays, which could nullify most of the ACM potential performance gain. This paper proposes an effective FPGA tailored clock manipulation approach able to leverage the ACM potential. We first evaluate Clock Stretching (CS), i.e., the temporary clock period augmentation, as a CM alternative in FPGA processor designs and introduce an FPGA specific CS circuit implementation. Subsequently, we evaluate the advantages and drawbacks of the two techniques and propose a Hybrid ACM, which monitors the processor instruction stream and determines the optimal adaptive clocking strategy in order to provide the maximum speedup for the executing program. Given that CS has very low latency at the expense of limited accuracy and dynamic range we rely on it when the program requires frequent clock period changes. Otherwise we utilise CM, which is rather slow but enables the FPGA processor operation at the edge of its hardware capabilities. We evaluate our proposal on a vector processor mapped on a Xilinx Zynq FPGA. Our experiments indicate that on Sum of Squared Differences algorithm, Neural network, and FIR filter execution traces the hybrid ACM provides up to 1.14×/1.9× performance increase over the CM based ACM.

Download Paper (PDF; Only available from the DATE venue WiFi)
10.6 Circuit Design and Test: From Characterization to Measurement

**Date:** Thursday 12 March 2015  
**Time:** 11:00 - 12:30  
**Location / Room:** Bayard

**Chair:**  
Salvador Mir, TIMA/CNRS, FR

**Co-Chair:**  
Christoph Grimm, University of Kaiserslautern, DE

This session covers eye-diagram analysis for high-speed circuits, statistical digital library characterization, analog test ordering in the context of multi-site testing, and estimation of defect detection probability of analog test.

<table>
<thead>
<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
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<tbody>
<tr>
<td>11:00</td>
<td>10.6.1</td>
<td>(Best Paper Award Candidate) FAST EYE DIAGRAM ANALYSIS FOR HIGH-SPEED CMOS CIRCUITS</td>
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<td>Seyed Nematiollah Ahmadyan(^1), Chenjie Gu(^2), Suriyaprapaksha Natarajan(^2), Eli Chiprout(^2) and Shobha Vasudevan(^1)</td>
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<td></td>
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<td>(^1)University of Illinois at Urbana-Champaign, US; (^2)Intel, US</td>
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<td><strong>Abstract</strong></td>
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<td>We present an efficient technique for analyzing eye diagrams of high speed CMOS circuits in the presence of non-idealities like noise and jitter. Our method involves geometric manipulations of the eye diagram topology to find area within the eye contours. We introduce random tree based simulations as an approach to computing the desired area. We typically show $20\times$ speedup in generating the eye diagram as compared to the state-of-the-art Monte Carlo simulation based eye diagram analysis. For the same number of samples, Monte Carlo produces an eye diagram that is $8.51%$ smaller than the ideal eye diagram. We generate an eye diagram that is $53.52%$ smaller than the ideal eye, showing a $47%$ improvement in quality.</td>
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<td>11:30</td>
<td>10.6.2</td>
<td>STATISTICAL LIBRARY CHARACTERIZATION USING BELIEF PROPAGATION ACROSS MULTIPLE TECHNOLOGY NODES</td>
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<td>Li Yu(^1), Sharad Saxena(^2), Christopher Hess(^2), Ibrahim Elfadel(^1), Dimitri Antoniadis(^1) and Duane Boning(^1)</td>
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<td>(^1)Massachusetts Institute of Technology, US; (^2)PDF Solutions, Inc, US; (^3)Masdar Institute of Science and Technology, AE</td>
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<td><strong>Abstract</strong></td>
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<td>In this paper, we propose a novel flow to enable computationally efficient statistical characterization of standard cell libraries. The distinguishing feature of the proposed method is the usage of a limited combination of output capacitance, input slew rate and supply voltage for the extraction of statistical timing metrics of an individual logic gate. The efficiency of the proposed flow stems from the introduction of a novel, ultra-compact, nonlinear, analytical timing model, having only four universal regression parameters. This novel model facilitates the use of maximum-a-posteriori belief propagation to learn the prior parameter distribution for the parameters of the target technology from past characterizations of library cells belonging to various other technologies, including older ones. The framework then utilizes Bayesian inference to extract the new timing model parameters using an ultra-small set of additional timing measurements from the target technology. The proposed method is validated and benchmarked on several production-level cell libraries including a state-of-the-art 14-nm technology node and a variation-aware, compact transistor model. For the same accuracy as the conventional lookup-table approach, this new method achieves at least $15\times$ reduction in simulation runs.</td>
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<td>12:00</td>
<td>10.6.3</td>
<td>COMBINING ADAPTIVE ALTERNATE TEST AND MULTI-SITE TEST</td>
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<td><strong>Abstract</strong></td>
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<td>Testing analog, mixed-signal and RF circuits represents one of the main cost components for complex SoCs. Multisite Testing is widely accepted as a straightforward technique to reduce the effective test time. This paper shows that an adaptive Alternate Test approach can be compatible with a multisite strategy. The proposed solution consists in ordering offline the signatures acquisition sequence and training incremental regression models for each new feature. These models can be used to diagnose the circuit as good, provided that the estimate of the performance is larger than the specification plus a guard-band related to the model error. If all the sites are diagnosed as good, the test program can be halted before completion. This decision is taken online and makes this scheme adaptive. We provide an analytical study of the expected test time reduction and of the test escape penalty that is incurred. Results obtained from post-layout Monte-Carlo simulations of an UMA demonstrate the validity of the approach and show that significant test time improvements can be obtained, even for large number of sites, whenever the manufacturing yield is sufficiently high. Download Paper (PDF; Only available from the DATE venue WiFi)</td>
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<td>12:15</td>
<td>10.6.4</td>
<td>A METHOD FOR THE ESTIMATION OF DEFECT DETECTION PROBABILITY OF ANALOG/RF DEFECT-ORIENTED TESTS</td>
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<td>John Lapierdos1, Angela Araproyanni2 and Yiorgos Tsiatouhas3</td>
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<td><strong>Abstract</strong></td>
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<td>A method to realistically estimate the defect detection probability achieved by defect-oriented analog/RF integrated circuit tests at the circuit design level is presented in this paper. The proposed method also provides insight to the efficiency of the various available defect-oriented testing techniques, thus allowing the selection of the most suitable for a specific circuit. The effect of structural defects in the presence of process variations and device mismatches is taken into account, by the exploitation of the defect probability distributions and the statistical models of the used technology. Although the proposed methodology is generally applicable to the entire class of analog circuits, its application to simple RF circuits which consist of a few elements seems to be more practical, due to the affordable computational cost implied by circuits with shorter defect dictionaries. In order to obtain results without a reliability compromise, the number of required statistical simulation runs is reduced through regression. The application of the proposed method on a typical RF mixer, designed in a 0.18um CMOS technology, is also presented. Download Paper (PDF; Only available from the DATE venue WiFi)</td>
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<tr>
<td>12:30</td>
<td>IPS-5</td>
<td>EMPIRICAL MODELLING OF FDSOI CMOS INVERTER FOR SIGNAL/POWER INTEGRITY SIMULATION</td>
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<td>212</td>
<td><strong>Speakers:</strong></td>
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<td>Wael Dghais and Jonathan Rodriguez, Instituto de Telecomunicacoes, PT</td>
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<td><strong>Abstract</strong></td>
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<td>This paper presents a multiport empirical model based on artificial neural network for I/O memory interface (e.g. inverter) designed based on fully depleted silicon on isolator (FDSOI) CMOS 28 nm process for signal and power integrity assessments. The analog mixed-signal identification signals that carry the information about the I/O interface’s nonlinear dynamic behavior are recorded from large signal simulation setup. The model’s functions are extracted based on a nonlinear optimization algorithm and then implemented in Simulink software. The performance of the resulting model is validated in typical power and ground switching noise scenario. The developed empirical model accurately predicts the timing signal waveforms at the power, ground, and at the output port. Download Paper (PDF; Only available from the DATE venue WiFi)</td>
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<td>12:31</td>
<td>IPS-6</td>
<td>ON-CHIP MEASUREMENT OF BANDGAP REFERENCE VOLTAGE USING A SMALL FORM FACTOR VCO BASED ZOOM-IN ADC</td>
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<td><strong>Speakers:</strong></td>
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<td>Osman Erol1, Sule Ozev1, Chandra K. H. Suresh2, Rubin Parekhji3 and Lakshmanan Balasubramanian3</td>
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<td><strong>Abstract</strong></td>
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<td>A robust and highly scalable technique for measuring the output voltage of a band-gap reference (BGR) circuit is described. The proposed technique is based on an ADC architecture that uses a voltage controlled oscillator (VCO) for voltage to frequency conversion. During production testing, an external voltage reference is used to approximate the voltage/frequency characteristics of the VCO with 5ms test time. The proposed zoom-in ADC approach is manufactured with 0.5um single well CMOS process. Measurement results indicate that 13 bits of resolution within the measurement range can be achieved with the zoom-in approach. Worst-case INL for the ADC is less than 0.25LSB (50μV). Download Paper (PDF; Only available from the DATE venue WiFi)</td>
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<td>12:30</td>
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<td>Lunch Break, Keynote lecture from 1320 - 1350 (Room Oisans) in Les Ecrins</td>
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<td>Coffee Break in Exhibition Area</td>
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|            |      | On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area. Lunch Break On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Ecrins (for fully registered conference delegates only). Lunch Break Tuesday, March 10, 2015 Coffee Break 10:30 - 11:30 Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics Coffee Break 16:00 - 17:00 Wednesday, March 11, 2015 Coffee Break 10:00 - 11:00 Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans) Coffee Break 16:00 - 17:00 Thursday, March 12, 2015 Coffee Break 10:00 - 11:00 Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50 Coffee Break 15:30 - 16:00
The first two papers propose improved solutions for error diagnosis and software bounded model checking. The next two papers are devoted to abstraction and synthesis techniques between RTL and high-level models of on-chip communication networks. Then the first IP expands the applicability of equivalence checkers to asynchronous circuits. The last two IPs present emerging applications of model checking.

**Time** | **Label** | **Presentation Title** | **Authors**
--- | --- | --- | ---
11:00 | 10.7.1 | **AUTOMATED RECTIFICATION METHODOLOGIES TO FUNCTIONAL STATE-SPACE UNREACHABILITY** | Ryan Berryhill and Andreas Veneris, University of Toronto, CA
**Abstract**
In the modern design cycle significant manual resources are dedicated to fix a design when verification shows that a state is not reachable. As traditional debugging typically involves the use of an error trace that exhibits the problem, there is little automation to aid an engineer understand why a state is not reachable and how to correct this problem. This paper presents a novel methodology that automates this task. In detail, a process that involves intertwined steps of state approximation, reachability analysis and traditional debugging is developed to identify design locations where fixes can be applied so that the target state becomes reachable. An initial formulation identifies such error locations when the target state is reachable directly from the reachable set of states. This is later extended for the cases where more than one state transition is required to reach an unreachable state from the existing reachable set. Empirical results on industrial level designs show a performance which is orders of magnitude faster than the state-of-the-art confirming the practicality of the proposed automated methodology.

Download Paper (PDF; Only available from the DATE venue WiFi)

11:30 | 10.7.2 | **OVER-APPROXIMATING LOOPS TO PROVE PROPERTIES USING BOUNDED MODEL CHECKING** | Priyanka Darke, Bharti Chimdyaivar, Venkatesh R, Ulika Shroti and Ravindra Metta, TCS, IN
**Abstract**
Bounded Model Checkers (BMCs) are widely used to detect violations of program properties up to a bounded execution length of the program. However when it comes to proving the properties, BMCs are unable to provide a sound result for programs with loops of large or unknown bounds. To address this limitation, we developed a new loop over-approximation technique LA. LA replaces a given loop in a program with an abstract loop having a smaller known bound by combining the techniques of output abstraction and a novel abstract acceleration, suitably augmented with a new application of induction. The resulting transformed program can then be fed to any bounded model checker to provide a sound proof of the desired properties. We call this approach, LA followed by BMC, as LABMC. We evaluated the effectiveness of LABMC on some of the SV-COMP14 loop benchmarks, each with a property encoded into it. Well known BMCs failed to prove most of these properties due to loops of large, infinite or unknown bounds while LABMC obtained promising results. We also performed experiments on a real world automotive application on which the well known BMCs were able to prove only one of the 186 array accesses to be within array bounds. LABMC was able to successfully prove 131 of those array accesses to be within array bounds.

Download Paper (PDF; Only available from the DATE venue WiFi)

12:00 | 10.7.3 | **AUTOMATIC EXTRACTION OF MICRO-ARCHITECTURAL MODELS OF COMMUNICATION FABRICS FROM REGISTER TRANSFER LEVEL DESIGNS** | Sebastiaan Joosten and Julien Schmaltz, Eindhoven University of Technology, NL
**Abstract**
Multi-core processors and Systems-on-Chips are composed of a large number of processing and memory elements interconnected by complex communication fabrics. These fabrics are large systems made of many queues and distributed control logic. Recent studies have demonstrated that high levels models of these networks are either tractable for verification or can provide key invariants to improve hardware model checkers. Formally verifying Register Transfer Level (RTL) designs of these networks is an important challenge, yet still open. This paper bridges the gap between high level models and RTL designs. We propose an algorithm that from a Verilog description automatically produces its corresponding micro-architectural model. We prove that the extracted model is transfer equivalent to the original RTL circuit. We illustrate our approach on a typical example of communication fabrics: a scoreboard with credit-flow control.

Download Paper (PDF; Only available from the DATE venue WiFi)

12:15 | 10.7.4 | **GALS SYNTHESIS AND VERIFICATION FOR XMAS MODELS** | Frank Burns, Danil Sokolov and Alex Yakovlev, Newcastle University, GB
**Abstract**
In this paper a novel Globally Asynchronous Locally Synchronous--(GALS) synthesis and verification environment is introduced for xMAS models. xMAS models are a new communication paradigm which can be used to model circuits and networks for the purpose of synthesis, testing and verification. Previous attempts at synthesis and verification of xMAS models have been proposed for synchronous implementations only. This paper provides an extension of xMAS and translation into Circuit Petri net models for GALS synthesis and verification. Synthesis techniques based on Circuit Petri net translation are presented and a new xMAS component is introduced which acts as a wrapper for different GALS styles. Novel verification techniques using unfolding to occurrence nets are then proposed. Our results show that the work presented here provides a suitable platform for integrating xMAS into a GALS environment.

Download Paper (PDF; Only available from the DATE venue WiFi)

12:30 | 10.7.5 | **LOGICAL EQUIVALENCE CHECKING OF ASYNCHRONOUS CIRCUITS USING COMMERCIAL TOOLS** | Arash Saifhashemi, Hsin-Ho Huang, Priyanka Bhalerao and Peter Beerel
**Abstract**
We propose a method for logical equivalence check (LEC) of asynchronous circuits using commercial synchronous tools. In particular, we verify the equivalence of asynchronous circuits which are modeled at the CSP-level in SystemC/Vlog as well as circuits modeled at the micro-architectural level using conditional communication library primitives. Our approach is based on a novel three-valued logic model that abstracts the detailed handshaking protocol and is thus agnostic to different gate-level implementations, making it applicable to a variety of different design styles. Our experimental results with commercial LEC tools on a variety of computational blocks and an asynchronous microprocessor demonstrate the applicability and limitations of the proposed approach.

Download Paper (PDF; Only available from the DATE venue WiFi)
Such an extension aims at optimizing the tool cost for large enterprises using extensively and at a large scale a variety of development tools and gives an unique corporate global view on IP and Tools.

It will also be demonstrated that an amazing and straightforward extension concerns EDA Tool license management and optimization including integrated license monitoring.

Specific views namely Engineering view and Legal aspects will be commented by 2 speakers from companies veteran in IP management.

Today an IP management platform needs to be a next generation web application hosted on an intranet server and receiving data from multiple sources (Design DB, IP Delivery DB, Product Shipment DB, Legal and Financial reports...). It aims at providing a reliable follow up to all of these departments such as IP Entry, IP Delivery, IP tracing in products…

It delivers results (fee and royalty calculation for instance) as well as expertise for decision making (planning the future in terms of IP expenses, cost per product...).

IPs are today part of any Electronic Systems and it is more and more urgent to trace, monitor and more generally "manage" IPs in systems or products. The key feature of such a management is its multidisciplinary facet implying multiple management views and actors (IP Engineering, IP Sourcing, IP Procurement...).

Abstract

Embedded software systems are frequently modeled as a set of synchronous reactive processes. The transitions performed by the processes are given as sequential, atomic code blocks. Most existing verifiers flatten such programs into a global transition system, to be able to apply off-the-shelf verification methods. However, this monolithic approach fails to exploit the lock-step execution of the processes, severely limiting scalability. We present a novel formal verification technique that analyses synchronous concurrency explicitly rather than encoding it. We present a variant of Lazy Abstraction with Interpolants (LAWI), a technique successfully used in software verification, and tailor it to synchronous reactive concurrency. We exploit the synchronous communication structure by fixing an execution schedule, circumventing the exponential blow-up of state space caused by simulating synchronous behaviour by means of interleavings. The technique is implemented in SYMPARA, a verification tool for synchronous reactive systems. To evaluate the effectiveness of our technique, we compare SYMPARA with Bounded Model Checking and k-induction, and a LAWI-based verifier for multi-threaded (asynchronous) software. On several realistic examples SYMPARA outperforms the other tools by an order of magnitude.

Kumar Madhukari, Mandayam Sirivas, Bjorn Wachter, Daniel Kroening and Ravindra Metta

1 Tata Research Development and Design Center, IN; 2 Chennai Mathematical Institute, IN; 3 University of Oxford, GB

Download Paper (PDF; Only available from the DATE venue WiFi)

Lunch Break

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Lunch Break

On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Écrins (for fully registered conference delegates only).

Tuesday, March 10, 2015
Coffee Break 10:30 - 11:30
Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
Coffee Break 16:00 - 17:00

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Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

10.8 From IP to EDA Tools Enterprise Management: What is so special?

Date: Thursday 12 March 2015
Time: 11:00 - 12:30
Location / Room: Salle Lesdiguières

Moderator: Gabriele Saucier, Design and Reuse, FR

Panelists: Huy-Nam Nguyen, Bull S.A.S., FR
Philippe Quinio, STMicroelectronics International, CH

IPs are today part of any Electronic Systems and it is more and more urgent to trace, monitor and more generally "manage" IPs in systems or products. The key feature of such a management is its multidisciplinary facet implying multiple management views and actors (IP Engineering, IP Sourcing, IP Procurement...).

Today an IP management platform needs to be a next generation web application hosted on an intranet server and receiving data from multiple sources (Design DB, IP Delivery DB, Product Shipment DB, Legal and Financial reports...). It aims at providing a reliable follow up to all of these departments such as IP Entry, IP Delivery, IP tracing in products...

It delivers results (fee and royalty calculation for instance) as well as expertise for decision making (planning the future in terms of IP expenses, cost per product...).

The introductory talk will show how such a portal can be configured to fulfill the needs of an enterprise and what are the required "special" technical features missing in management tools presently available on the market.

Specific views namely Engineering view and Legal aspects will be commented by 2 speakers from companies veteran in IP management.

It will also be demonstrated that an amazing and straightforward extension concerns EDA Tool license management and optimization including integrated license monitoring. Such an extension aims at optimizing the tool cost for large enterprises using extensively and at a large scale a variety of development tools and gives an unique corporate global view on IP and Tools.
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<tr>
<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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<tbody>
<tr>
<td>11:00</td>
<td>10.8.1</td>
<td>IP AND EDA TOOL NEXT GENERATION MANAGEMENT PLATFORM: WHAT ARE THE FEATURES REQUIRED?</td>
<td>Panelist: Gabrièle Saucier, Design and Reuse, FR</td>
</tr>
<tr>
<td>11:45</td>
<td>10.8.3</td>
<td>BUSINESS AND LEGAL: THE SOURCING RISK</td>
<td>Panelist: Philippe Quinio, STMicroelectronics International, CH</td>
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<tr>
<td>12:05</td>
<td>10.8.4</td>
<td>QUESTIONS AND AUDIENCE COMMENTS</td>
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<td>12:30</td>
<td></td>
<td>End of session</td>
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<tr>
<td>11:00</td>
<td></td>
<td>Lunch Break, Keynote lecture from 1320 - 1350 (Room Oisans) in Les Écrins</td>
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<tr>
<td>11:30</td>
<td></td>
<td>Coffee Break in Exhibition Area</td>
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Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

**ÜB10 Session 10**
**Date:** Thursday 12 March 2015  
**Time:** 12:00 - 14:30  
**Location / Room:** University Booth, Booth 4, Exhibition Area

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<tr>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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</table>
| UB10.1| COMBINATION OF WSN AND 1ST ORDER KINETIC MODEL FOR REAL-TIME SHELF-LIFE PREDICTION OF PERISHABLE GOODS | Presenter: Valerio Francesco Annese, Politecnico di Bari, IT  
Author: Daniela De Venuto, Politecnico di Bari, IT  
Abstract  
A complete and autonomous multi-sensing platform for perishable goods monitoring and shelf-life prediction, based on the combination of the wireless sensor network (WSN) technology and a further real-time data processing, is presented. The proposed approach offers an effective solution for waste and losses reduction in the supply chain of perishable products and, thus, an improvement of food safety, as well as food organoleptic qualities: in fact, we demonstrate the possibility to predict products shelf-life from the environment parameters such as temperature, relative humidity and light exposition in real-time. Although several models for shelf-life prediction have been already developed, none of them was embedded in a complete system supported by the real-time data availability, offered by an “ad hoc” WSN. In our infrastructure, system integration issues are carefully solved: data collected by the WSN are firstly uploaded on a cloud. An appropriate Java application makes these data available to any kind of elaboration. Then, we developed an algorithm that implements a 1st order kinetic model of the quality decay reaction, employed to evaluate remaining shelf-life of the monitored perishable product. The model takes into account the dependence of the degradation rate from the temperature according to Arrhenius law. To validate the platform we have conducted several case studies. Here we propose an 8-days monitoring of a warehouse of vegetable products (fresh tomatoes): the real-time shelf-life prediction was calculate through data coming from six multi-sensing nodes that were monitoring several environmental conditions in which the products were subjected. The implementation of the algorithm in an application for any kind of portable and non-portable devices (just like an iPad, smartphones, etc.) would result in a widespread diffusion of this technology. It is worth to notice that the complete infrastructure is a suitable low-cost and easy to implement solution for monitoring any perishable product (such as beverages, drugs, vaccines, blood, etc.) stored in any environmental condition (warehouse, transportation, store, etc.). |
| UB10.2| NETFPGA SUME: MAKING 100GBPS A COMMODITY                                              | Presenter: Noa Zilberman, University of Cambridge, GB  
Authors: Yuri Audzevich, Georgina Kalogeridou and Andrew W. Moore, University of Cambridge, GB  
Abstract  
The demand-led growth of datacenter networks has meant that many constituent technologies are beyond the budget of the wider community. In order to make and validate timely and relevant new contributions, the wider community requires accessible evaluation, experimentation and demonstration environments with specification comparable to the subsystems of the most massive datacenter networks. We will demonstrate NetFPGA SUME, an open-source FPGA-based PCIe board with I/O capabilities for 100Gbps operation as NIC, multiprotocol switch, firewall, or test/measurement environment. |
Abstract

In this demonstration, we explain how we ported a Linux-based Operating System to the TSAR manycore architecture. In the associated poster, we describe the TSAR architecture and enumerate the pieces of software that usually need to be ported for a new processor architecture, and we give further details about our port. We also demonstrate this work by running Linux on an FPGA-based prototype of TSAR. The demo shows the entire boot process, from the powerup to the terminal prompt where the user can type in commands and interact with the hardware system.

More information ...

Designing and Evaluating Resource Management Policies for Heterogeneous System Architectures

Abstract

Current trends in computing architectures are going in the direction of heterogeneous systems (i.e. constituted by CPUs, GPUs, and FPGAs). The design space to effectively exploit these platforms is huge. Within this context, research is moving towards systems able to adapt themselves to a wide range of workloads to optimize performance/energy trade-offs. We propose a virtual platform (VP) to help designers to develop adaptive policies. The VP allows to perform an high-level evaluation of the policies with the possibility to customize both the architecture and the workload mix.

More information ...

Real-time Pattern Detection of Movement Related Potentials by Synchronized EEG and EMG

Abstract

The gateway unit (a smartphone or a tablet) receives the EEG and EMG sensor data and performs signal analysis to identify possible MRPs patterns through wavelet analysis. In this contribute it will be delineated as case study the possible implementation in fall prevention where not only the unwanted muscle movement is detected but also a bio-feedback is activated to block the muscle and inform an assistive center. Nevertheless, the field of application of the system here presented covers a wide range of AAL applications including fall prevention, rehabilitation (i.e. walk monitoring), artificial limb control and neurodegenerative diseases diagnosis.

More information ...

The ψ-Chart Design Approach in TTtool/DiploDocus: A Framework for HW/SW Co-design of Data-dominated Systems-on-Chip

Abstract

In the scope of the DATE 2015 University Booth, we present our latest achievements for the system level design of parallel and distributed embedded systems. We propose a demonstration of a novel design approach, the ψ-chart, in TTtool/DiploDocus, a UML/SysML framework for the design, validation and automatic code generation for data-dominated SoCs. The ψ-chart is a design approach where communication patterns are designed with dedicated models, independently of a pair application-architecture, before mapping phase. It allows for a complete orthogonalization of concerns between the design of computations and communications, thus achieving faster Design Space Exploration, complete design portability as well as reduced design times and costs. The subject of our demonstration is the design of the physical layer (PHY) of the transmitter part of the Zigbee wireless standard (IEEE 802.15.4) mapped onto an MPSoC architecture with shared memory. Our demonstration will illustrate the full design of the Zigbee transmitter, from models to the automatic generation of the emulation code, via simulation and formal verification. We will validate our design by comparing the output samples produced by the emulation code, with a real implementation of the transmitter on a FPGA prototyping board.
**UB10.8 INTERACTIVE VISUALIZATION OF ESL DESIGNS**

**Presenter:**
Jannis Stoppe, University of Bremen, DE

**Authors:**
Robert Wille and Rolf Drechsler, University of Bremen/DFKI GmbH, DE

**Abstract:**
In this work, we propose an improved visualization tool for SystemC which assists a designer in communicating a system’s structure and behavior. Please see the uploaded pdf-file for details.

More information ...

**UB10.9 MAMMA: SPEECH ENHANCEMENT DEMO EXPLOITING MEMS MICROPHONE ARRAY FOR PEOPLE WITH DISABILITIES**

**Presenter:**
Luca Sarti, University of Pisa, IT

**Authors:**
Alessandro Palla¹, Luca Fanucci¹ and Roberto Sannino²
¹University of Pisa, IT; ²STMicroelectronics, IT

**Abstract:**
Disabled people, especially the ones with motor skill impairments, have difficulties in interaction with electronic devices. Indeed voice recognition could be exploited, but its performance strongly depends by the environmental noise. We propose a wearable speech enhancement system based on MEMS microphone array and an ARM Cortex M4 CPU featuring a beamforming technique and an adaptive acoustic echo cancellation filtering in order to increase SNR of acquired voice stream. An increase by 16.5 dB in the SNR is obtained when noise and voice come from opposite directions. Theoretical analysis and in-system measurements prove the effectiveness of the proposed solution.

More information ...

14:30 End of session

15:30 Coffee Break in Exhibition Area

Coffee Break in Exhibition Area

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Coffee Break 16:00 - 17:00

**Thursday, March 12, 2015**

Coffee Break 10:00 - 11:00

Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50

Coffee Break 15:30 - 16:00

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**11.0 SPECIAL DAY Keynote**

**Date:** Thursday 12 March 2015

**Time:** 13:15 - 14:00

**Location / Room:** Salle Oisans

**Chair:**
Jo De Boeck, IMEC, BE

**Co-Chair:**
David Atienza, École Polytechnique Fédérale de Lausanne (EPFL), CH

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<thead>
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<tr>
<td>13:15</td>
<td>11.0.1</td>
<td>BEST IP AWARD PRESENTATION</td>
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<tr>
<td>Speaker:</td>
<td>Oliver Bringmann, University of Tuebingen / FZI, DE</td>
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| 13:20 | 11.0.2 | BIOELECTRONIC MEDICINES - HERALDING IN A NEW THERAPEUTIC APPROACH |
| Speaker: | Kristoffer Famm, GSK, GB |

**Abstract:**
Imagine a day when electrical impulses are a mainstay of medical treatment, a day when your doctor will routinely administer microscopic devices that modulate signals in specific nerves for treatment effect. Every organ in our bodies is wired and controlled by nerves, so bioelectronic medicines may be applicable across a broad range of diseases just like molecular medicines are today. Through bioelectronic medicines, GSK, a leading pharmaceutical company, and its extensive network of research collaborators aim to bring the precision and intelligence of electronics right to the core of future treatments.

14:00 End of session
Coffee Break in Exhibition Area

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Coffee Break 15:30 - 16:00

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### 11.1 SPECIAL DAY Hot Topic: Implantable Medical Applications

**Date:** Thursday 12 March 2015  
**Time:** 14:00 - 15:30  
**Location / Room:** Salle Oisans

**Organiser:**  
Jo De Boeck, IMEC, BE

**Chair:**  
Refet Firat Yazicioglu, IMEC, BE

**Co-Chair:**  
Jean-Paul Linnartz, Philips, NL

Implantable devices obviously have stringent technical requirements dictated by the specific functionality in the body. This session brings expert views from industry leaders in the field and insight in the challenges for integrated circuits in emerging biomedical devices.

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<th>Time</th>
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<th>Authors</th>
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<tbody>
<tr>
<td>14:00</td>
<td>11.1.1</td>
<td>ACTIVE IMPLANTABLE MEDICAL DEVICES</td>
<td>Renzo Dal Molin, Sorin Group, FR</td>
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<td></td>
<td></td>
<td><strong>Abstract</strong></td>
<td>Saving lives with cutting-edge technology is at the heart of active implantable medical devices. The introduced technology innovations are developed targeting both patients and health economic outcomes, they also contribute to a more efficient healthcare.</td>
</tr>
<tr>
<td>14:30</td>
<td>11.1.2</td>
<td>TOWARDS NEXT GENERATION DEEP BRAIN STIMULATION</td>
<td>Michael Decré, Medtronic Eindhoven Design Center, NL</td>
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<tr>
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<td></td>
<td><strong>Abstract</strong></td>
<td>Deep Brain Stimulation (DBS) should soon reach a profound transformation step with the inclusion of high-resolution probes and active sensing. This will allow very precise brain modulation, enable chronic disease monitoring and finally open up closed-loop stimulation research. Driven by therapeutic improvements, Medtronic is actively pursuing its innovation agenda for the future of DBS.</td>
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<tr>
<td>15:00</td>
<td>11.1.3</td>
<td>INTEGRATED CIRCUITS AND MICROSYSTEMS FOR EMERGING BIOMEDICAL DEVICES</td>
<td>Minkyu Je, DGIST, Daegu Gyeongbuk Institute of Science and Technology, KR</td>
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<tr>
<td></td>
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<td><strong>Abstract</strong></td>
<td>IC technologies and integrated microsystems enable emerging biomedical devices by providing seamless interface to various sensors and actuators, high-efficiency operation with various energy sources (especially, renewable ones), high-level integration and miniaturization, embedded intelligence, and connectivity.</td>
</tr>
</tbody>
</table>
11.2 Variability and Robustness for Emerging Technologies

**Date:** Thursday 12 March 2015  
**Time:** 14:00 - 15:30  
**Location / Room:** Belle Etoile

**Chair:** Edith Beigne, CEA-Leti, FR  
**Co-Chair:** Andy Tyrrell, University of York, GB

Issues relating to smaller device sizing and novel technologies require more consideration of variability when designing systems and the related robustness of such systems. The first paper in this session considers the modelling of resistive switching random access memory and used in a number of designs to illustrate various properties and characteristics of such devices, including speed-power performance, variability and a neuromorphic computing application. The second paper introduces methods for improving the performance of Spin-Torque Transfer RAM (STTRAM) to reduce worst-case write latency and improve power over more global methods. The third paper proposes a joint optimization of the such devices, including speed-power performance, variability and a neuromorphic computing application. The second paper introduces methods for improving the performance of Spin-Torque Transfer RAM (STTRAM) to reduce worst-case write latency and improve power over more global methods. The third paper proposes a joint optimization of the variability can result in large spread in write and read latency variations. The performance of conventionally designed STTRAM cache can degrade as much as 10% due to process variations. We propose a novel and adaptive write current boosting to address this issue. The bits experiencing worst-case write latency are fixed through write current boosting. Simulations show 80% power improvement compared to boosting all bit-cells and 13% performance improvement compared to worst case latency due to process variation over a wide range of PARSEC benchmarks.

**Authors**  
Haitong Li  
Seyedhamidehra Motaman, Swaroop Ghosh and Nitin Rathi, University of South Florida, US

**Speakers**  
Haitong Li, Zizhen Jiang, Peng Huang, Yi Wu, Hong-Yu Chen, Bin Gao, Xiaoyan Liu, Jinfeng Kang and H.-S. Philip Wong

**Abstract**  
Resistive switching random access memory (RRAM) is a leading candidate for next-generation nonvolatile and storage-class memories and monolithic integration of logic with memory interleaved in multiple layers. To meet the increasing need of device-circuit-system co-design and optimization for applications from digital memory systems to brain-inspired computing systems, a SPICE model of RRAM that can reproduce essential device physics in a circuit simulation environment is required. In this work, we develop an RRAM SPICE model that can capture all the essential device characteristics such as stochastic switching behaviors, multi-level cell, switching voltage variations, and resistance distributions. The model is verified and calibrated by a variety of electrical measurements on ~10 nm RRAMs. The model is applied to explore a wide range of applications including: 1) variation-aware design; 2) reliability-emphasized design; 3) speed-power assessment; 4) array architecture optimization; and 5) neuromorphic computing. This experimentally verified design tool not only enables system design that includes the complete suite of RRAM device features, but also provides solutions for system optimization that capitalize on device/circuit interaction.

Download Paper (PDF; Only available from the DATE venue WiFi)
Abstract
Spin transfer torque magnetic random access memory (STT-MRAM), using magnetic tunnel junctions (MTJ) has garnered significant attention in the research community due to its immense potential for on-chip, high-density and non-volatile memory. However, process variations may significantly impact the achievable yield in STT-MRAM. To this end, several yield enhancement techniques that improve STT-MRAM failures at the bit-cell, and at the architecture level of design abstraction have been proposed in the literature. However, these techniques may lead to a suboptimal design because they do not consider the impact of design choices at every level of design abstraction. In this paper, we propose a unified device-circuit-architecture co-design framework to optimize and enhance the yield of STT-MRAM. We studied the interaction between device parameters (viz. energy barrier height) and bit-cell level parameters (viz. transistor width), together with different Error Correcting Codes (ECC) to optimize the robustness and energy efficiency of STT-MRAM cache. The advantages of our proposed approach to STT-MRAM design are explored at the 32nm technology node. We show that for a target yield of 500 Defects Per Million (DPM) for an example array with 64-bit word length, our proposed ap-proach with realistic parameters can save up to 15% and 13% in cell area and total power consumption, respectively, in compar-ison with a design that does not use any array level yield en-hancement technique.

Download Paper (PDF; Only available from the DATE venue WiFi)
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<td>15:30</td>
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<td>Coffee Break in Exhibition Area</td>
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<td>Coffee Break 15:30 - 16:00</td>
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### 11.3 Hot Topic - Multi/Many-Core Programming: Where Are We Standing?

**Date:** Thursday 12 March 2015  
**Time:** 14:00 - 15:30  
**Location / Room:** Stendhal

**Organisers:**  
Rainer Leupers, RWTH Aachen, DE  
Jeronimo Castrillon, Technische Universität Dresden, DE

**Chair:**  
Norbert Wehn, University of Kaiserslautern, DE  
**Co-Chair:**  
Ayse K. Coskun, Boston University, US

Multi-processor systems have been in wide use for about ten years. During this time, several programming models have appeared in different domains. In particular, the academic community has been active in devising methods, often model-driven, to program heterogeneous embedded multi-processor platforms. This session analyzes the current standing from different perspectives, namely, from researchers working in methods in academia, from companies offering solutions and from companies requiring solutions.

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<tr>
<td>14:00</td>
<td>11.3.1</td>
<td>5% OR 5X? THE PERFORMANCE GAP IN SIMD OPTIMIZATION, AND POSSIBLE SOLUTIONS</td>
<td>Ben Juurlink, TU Berlin, DE</td>
</tr>
<tr>
<td>14:15</td>
<td>11.3.2</td>
<td>MODEL-BASED DESIGN OF REAL-TIME SYSTEMS</td>
<td>Lothar Thiele, Swiss Federal Institute of Technology in Zurich (ETHZ), CH</td>
</tr>
<tr>
<td>14:30</td>
<td>11.3.3</td>
<td>PROGRAMMING ADAPTIVE AND ENERGY-EFFICIENT MANY-CORES</td>
<td>Jeronimo Castrillon, Technische Universität Dresden, DE</td>
</tr>
<tr>
<td>14:45</td>
<td>11.3.4</td>
<td>CONFIDENCE IN THE USE OF SOFTWARE TOOLS ACCORDING TO THE ISO 26262 IN AUTOMOTIVE MULTICORE APPLICATIONS</td>
<td>Ralph Jessenberger, BeOne Frankfurt GmbH, DE</td>
</tr>
<tr>
<td>15:00</td>
<td>11.3.5</td>
<td>AUTOMOTIVE MULTICORE MICROCONTROLLER SIMULATION, DEBUGGING AND ANALYSIS USING VIRTUAL PROTOTYPES</td>
<td>Victor Reyes, Synopsys Inc., US</td>
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</table>

**Abstract**  
As the amount of software in the car continues growing, automotive companies have shifted to multicore microcontroller architectures as a way to contain both the number of ECUs (cost) and their power consumption (mileage). New multicore microcontrollers can deliver more performance and hence allow mapping more functions on it. At the same time, this extra performance is delivered at clock frequencies comparable to previous generations, hence keeping the more and more important power consumption under control. New challenges both from functional and performance angles are introduced when porting an existing software stack to a new multicore microcontroller architecture. From the functional aspect, new bugs such as race conditions, data coherence, etc are introduced. From the performance angle, different functions running on different cores do still share all other hardware resources, such as memories, on-chip busses and peripherals, which may introduce significant jitter on the software execution. Finding the appropriate configuration of such hardware resources that provides sufficient performance in all conditions is a daunting task. This is all very important especially for safety critical applications where "freedom of interference" must be ensured to achieve certification. In this presentation we will discuss, how multicore microcontroller simulation models (a.k.a. virtual prototypes) are used nowadays throughout the Automotive Supply chain, from Semiconductor companies, to Tier1 and to OEMs, to deal with the challenges of debugging and analyzing software on multicore architectures.

| 15:15  | 11.3.6 | APPLYING MULTICORE COMPILER RESEARCH INTO INDUSTRIAL PRACTICES: AN EARLY EXPERIENCE REPORT | Weihua Sheng, Silexica Software Solutions GmbH, DE |
### 11.4 Logic Synthesis: the Faithful, the Approximate and the Stochastic

**Date:** Thursday, 12 March 2015  
**Time:** 14:00 - 15:30  
**Location / Room:** Chartreuse

**Chair:**  
Alex Yakovlev, University of Newcastle, GB

**Co-Chair:**  
Mohamed Sabry, Stanford University, US

Logic synthesis is evolving from traditional frameworks with fully-defined Boolean functions to account for the flexibilities afforded by observability don’t cares, to generate smaller circuits through approximation and improve power-performance tradeoffs by taming stochastic computation.

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<th>Time</th>
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<th>Presentation Title</th>
<th>Authors</th>
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| 14:00  | 11.4.1 | **A NEW APPROXIMATE ADDER WITH LOW RELATIVE ERROR AND CORRECT SIGN CALCULATION**   | Junjun Hu\(^1\) and Weikang Qian\(^2\)  
\(^1\)Shanghai Jiao Tong University, CN;  
\(^2\)Shanghai Jiao Tong University (SJTU), CN

**Abstract**  
Conventional precise adders need long delay and large power consumption to obtain accurate results. However, in recognition of the error tolerance of some applications such as multimedia processing and machine learning, a few recent works proposed approximate adders that generate inaccurate results occasionally to reduce the delay and power consumption. However, existing approximate adders rarely control the relative error and the potential sign error of the calculation results. In this paper, we propose a novel approximate adder that exploits the generate signals for carry speculation. Furthermore, we introduce a very low-cost error reduction module to effectively control the maximal relative error and a low-overhead sign correction module to fix the sign errors. Compared to the conventional adders, our adder is up to 4.3x faster and saves 47% power for a 32-bit addition. Compared to the existing approximate adders, our adder significantly reduces the maximal relative error and ensures correct sign calculation with comparable area, delay, and power consumption. |

**Download Paper (PDF; Only available from the DATE venue WiFi)**

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<th>Presentation Title</th>
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| 14:30  | 11.4.2 | **TOWARDS BINARY CIRCUIT MODELS THAT FAITHFULLY CAPTURE PHYSICAL SOLVABILITY**      | Matthias Fuegger\(^1\), Robert Najvirt\(^1\), Thomas Nowak\(^2\) and Ulrich Schmid\(^1\)  
\(^1\)TU Wien, AT;  
\(^2\)École Normale Supérieure, FR

**Abstract**  
In contrast to analog models, binary circuit models are high-level abstractions that play an important role in assessing the correctness and performance characteristics of digital circuit designs: (i) modern circuit design relies on fast digital timing simulation tools and, hence, on binary-valued circuit models that faithfully model signal propagation, even throughout a complex design, and (ii) binary circuit models provide a level of abstraction that is amenable to formal correctness proofs. A mandatory feature of any such model is the ability to trace glitches and other short pulses precisely as they occur in physical circuits, as their presence may affect a circuit’s correctness and its performance characteristics. Unfortunately, it was recently proved [Függer et al., ASYNC’13] that none of the existing binary-valued circuit models proposed so far, including the two most commonly used pure and inertial delay channels and any other bounded single-history channel, is realistic in the following sense: For the simple Short-Pulse Filtration (SPF) problem, which is related to a circuit’s ability to suppress a single glitch, they showed that every bounded single-history channel either contradicts the unsolvability of SPF in bounded time or the solvability of SPF in unbounded time in physical circuits, i.e., no existing model correctly captures physical solvability with respect to glitch propagation. We propose a binary circuit model, based on so-called involution channels, which do not suffer from this deficiency. In sharp contrast to what is possible with all the existing models, they allow to solve the SPF problem precisely when this is possible in physical circuits. To the best of our knowledge, our involution channel model is hence the very first binary circuit model that realistically models glitch propagation, which makes it a promising candidate for developing more accurate tools for simulation and formal verification of digital circuits. |

**Download Paper (PDF; Only available from the DATE venue WiFi)**
15:00 11.4.3 A ROBUST APPROACH FOR PROCESS VARIATION AWARE MASK OPTIMIZATION
Speakers: Yi Diao¹, Tak-Kei Lam², Xing Wei¹ and Yu-Liang Wu²
¹The Chinese University of Hong Kong, CN; ²The Chinese University of Hong Kong, HK
Abstract
Circuit size reduction is a basic problem in today’s integrated circuit (IC) design. Besides yielding a smaller area, reducing circuit size can also provide advantages in many operations throughout the design flow, including technology mapping, verification and place-and-route. In recent years, some node based logic synthesis algorithms have been proposed for this purpose. Node Addition and Removal (NAR) and Observability Don’t Cares (ODCs) based node merging were found to be quite effective in reducing the number of nodes in a netlist. However, both methods do not address the effect of re-distributing ODCs and the results are virtually fixed after one iteration run. We study the implications of redistributing ODCs and propose a node-based and wire-based coupling synthesis scheme that can effectively find better solutions with the application of ODC shifting operations. Experimental results show that this approach can produce area reductions nearly double of the pure node-based algorithms.
Download Paper (PDF; Only available from the DATE venue WiFi)

15:15 11.4.4 A ROBUST APPROACH FOR PROCESS VARIATION AWARE MASK OPTIMIZATION
Speakers: Zheng Zhao and Weikang Qian, Shanghai Jiao Tong University (SJTU), CN
Abstract
Stochastic computing (SC) is an unconventional paradigm to realize arithmetic computation, where real values are encoded as stochastic bit streams. Compared with conventional computation on binary radix encoding, SC can perform arithmetic computation with very simple circuits. It also has strong tolerance to soft errors. In this paper, we introduce a general design of combinational circuit for stochastic computing, together with its analysis. We further show a synthesis method that can implement arbitrary arithmetic functions with the proposed design. The experimental results demonstrated that compared with the previous methods, our approach produces a circuit with much smaller area and delay.
Download Paper (PDF; Only available from the DATE venue WiFi)

15:30 IPS-12, 647 A ROBUST APPROACH FOR PROCESS VARIATION AWARE MASK OPTIMIZATION
Speakers: Rohit Kumar, Bing Li², Yiren Shen² and Jiang Hu¹
¹Texas A&M University, College Station, US; ²Technische Universität München, DE
Abstract
An adaptive circuit can perform built-in self-detection of timing variations and accordingly adjust itself to avoid timing violations. Compared with conventional over-design approach, adaptive circuit design is conceptually advantageous in terms of power-efficiency. Although the advantage has been witnessed in numerous previous works including test chips, adaptive design is far from being widely used in practice. A key reason is the lack of corresponding timing verification support. We develop new timing analysis techniques to fill this void. A main challenge is the large runtime complexity due to numerous adaptivity configurations. We propose several pruning and reduction techniques and apply them in conjunction with statistical static timing analysis (SSTA). The proposed method is validated on benchmark circuits including the recent ISPD’13 suite, which has circuit as large as 150K gates. The results show that our method can achieve orders of magnitude speedup over Monte Carlo simulation with about the same accuracy. It is also several times faster than an exhaustive application of SSTA.
Download Paper (PDF; Only available from the DATE venue WiFi)

15:31 IPS-13, 87 TIMING VERIFICATION FOR ADAPTIVE INTEGRATED CIRCUITS
Speakers: Yi Diao¹, Tak-Kei Lam², Xing Wei¹ and Yu-Liang Wu²
¹The Chinese University of Hong Kong, CN; ²The Chinese University of Hong Kong, HK
Abstract
As the minimum feature size continues to shrink, whereas the wavelength of light used for lithography remains constant, Resolution Enhancement Techniques are widely used to optimize mask, so as to improve the subwavelength printability. Besides correcting for error between the printed image and target shape, a mask optimization method also needs to consider process variation. In this paper, a robust mask optimization approach is proposed to optimize the process window as well as the Edge Placement Error (EPE) of the printed image. Experiments results on the public benchmarks are encouraging.
Download Paper (PDF; Only available from the DATE venue WiFi)
11.5 Ultra-low Power Devices for Health and Rehabilitation

Date: Thursday 12 March 2015  
Time: 14:00 - 15:30  
Location / Room: Meije

Chair:  
Georgios Karakonstantis, Queen’s University, GB

Co-Chair:  
José M. Moya, Technical University of Madrid, ES

The session addresses scientific contribution in the field of ultra-low power devices and communication for medical, health and rehabilitation application. The first paper presents an innovative wearable device to assist writing rehabilitation. The next two papers cover different key aspects related to signal processing approaches for wireless compression and low-power coding for future Internet-of-Things (IoT) devices.

### Time | Label | Presentation Title | Authors
--- | --- | --- | ---
14:00 | 11.5.1 | PAPER, PEN AND INK: AN INNOVATIVE SYSTEM AND SOFTWARE FRAMEWORK TO ASSIST WRITING REHABILITATION | Leonardo Guardati\(^1\), Filippo Casamassima\(^2\), Elisabetta Farella\(^2\) and Luca Benini\(^3\)
\(^1\)Università di Bologna, IT; \(^2\)Fondazione Bruno Kessler, IT; \(^3\)Università di Bologna / Swiss Federal Institute of Technology in Zurich (ETHZ), CH

**Abstract**
Handwriting analysis and rehabilitation is an actively explored area in the diagnosis and treatment of Parkinson’s disease, which is usually performed in an ambulatory setting under direct supervision of a clinician. Technology enhanced handwriting is actively explored to reduce the need of physical co-presence of clinician and patient and to enhance diagnostic precision through the computation of non-subjective handwriting quality metrics. This paper introduces an innovative handwriting rehabilitation system for PD patients which ensures a natural writing experience as it is based on pen and paper (as opposed to tablet and stylus). The system is designed for human-in-the-loop operation and it can analyze handwriting in real-time and provide vocal feedback to guide the patient during the execution of exercises. We present a detailed comparative characterization of the key components of the system, namely wireless smart pens. In addition, in-field test assessed the system usability regarding its ease of use, calibration precision and vocal feedback effectiveness.

**Download Paper** (PDF; Only available from the DATE venue WiFi)

14:30 | 11.5.2 | AN ALL-DIGITAL SPIKE-BASED ULTRA-LOW-POWER IR-UWB DYNAMIC AVERAGE THRESHOLD CROSSING SCHEME FOR MUSCLE FORCE WIRELESS TRANSMISSION | Amirhasssen Shahshahani\(^1\), Masoud Shahshahani\(^2\), Maurizio Martina\(^1\), Guido Masera\(^1\), Danilo Demarchi\(^2\), Marco Crepaldi\(^3\), Paolo Motto Ros\(^3\) and Alberto Bonanno\(^3\)
\(^1\)Politecnico di Torino, IT; \(^2\)Politecnico di Torino / Istituto Italiano di Tecnologia@PolITo, IT; \(^3\)Istituto Italiano di Tecnologia@PolITo, IT

**Abstract**
We introduce an Impulse Radio Ultra-Wide Band (IR-UWB) radio transmission scheme for miniaturized biomedical applications based on a dynamic and adaptive voltage thresholding of surface Electro Myo Graphy (sEMG) signals. The amplified sEMG signal is compared to a DAC-generated threshold computed from the previous 1-bit history by custom digital control logic running at 2kHz clock and implementing an ad-hoc algorithm (Dynamic Average Threshold Crossing, D-ATC). The resulting events and the associated digitized voltage level can be both asynchronously radiated through IR-UWB. Analyses show that the scheme is robust w.r.t. the sEMG signal variability and correlates by 96% with regard to raw muscle force information after signal is recomputed at the RX. This paper compares DATC with regard to a fixed threshold system and an Average Threshold Crossing (ATC) demonstrating improved robustness, and introduces the thresholding algorithm verified on a dataset of 190 sEMG recorded signals. The applied threshold resolution has been optimized to both minimize the size of transmitted data and to guarantee good correlation performance. The paper concludes with post-synthesis results of the D-ATC compact digital control logic in a 0.18μm CMOS process, demonstrating an extremely low power consumption at very low active area expenses.

**Download Paper** (PDF; Only available from the DATE venue WiFi)
A PULSED-INDEX TECHNIQUE FOR SINGLE-CHANNEL, LOW-POWER, DYNAMIC SIGNALING

Speakers:
Shahzad Muzaffar, Jerald Yoo, Ayman Shabra and Ibrahim (Abe) Elfadel, Masdar Institute of Science and Technology, AE

Abstract
The most common operation of an IoT sensor is that of short activity bursts separated by long time intervals in sleep or listen modes. During the data bursts, sensed information has to be reliably communicated in real time without draining the energy resources of the sensor node. One way to save such resources is to efficiently code the data burst, use single-channel communication, and adopt ultra-low-power communication circuit techniques. Clock-data recovery (CDR) circuits are typically significant consumers of energy on traditional single-channel communication protocols. In this paper, we present a novel single-channel protocol that does not require any CDR circuitry. The protocol is based on the novel concept of a pulsed index where data is encoded to minimize the number of ON bits, move them to the LSB end of the packet, and transmit the ON bit indices in the form of a pulse stream. The pulse count is equal to the index of the ON bit. We call this protocol Pulsed Index Communication (PIC). Beside the elimination of CDR, we show that the implementation of PIC is very area-efficient, low-power and highly tolerant of clocking differences between transmitter and receiver. We present both an FPGA and an ASIC implementation of the protocol and use them to illustrate the performance, reliability and power consumption features of PIC signaling. In particular, we show that for an ASIC implementation on 65nm technology, PIC can reduce area by more than 80% and power by more than 70% in comparison with a CDR-based serial bit transfer protocol.

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15:30
End of session

Coffee Break in Exhibition Area

Coffee Break in Exhibition Area
On all conference days (Tuesday to Thursday), coffee and tea will be served during the coffee breaks at the below-mentioned times in the exhibition area.

Lunch Break
On Tuesday and Wednesday, lunch boxes will be served in front of the session room Salle Oisans and in the exhibition area for fully registered delegates (a voucher will be given upon registration on-site). On Thursday, lunch will be served in Room Les Ecrins (for fully registered conference delegates only).

Tuesday, March 10, 2015
Coffee Break 10:30 - 11:30
Lunch Break 13:00 - 14:30; Keynote session from 13:20 - 14:20 (Room Oisans) sponsored by Mentor Graphics
Coffee Break 16:00 - 17:00

Wednesday, March 11, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:30, Keynote lectures from 12:50 - 14:20 (Room Oisans)
Coffee Break 16:00 - 17:00

Thursday, March 12, 2015
Coffee Break 10:00 - 11:00
Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50
Coffee Break 15:30 - 16:00

11.6 Video Architectures for Multimedia and Communications

Date: Thursday 12 March 2015
Time: 14:00 - 15:30
Location / Room: Bayard
Chair: Frederic Petro, TIMA, FR
Co-Chair: Marcello Coppola, STMicroelectronics, FR

This session presents innovative work in video architectures and algorithms used in multimedia and communication systems.

14:00 11.6.1 SAPPHIRE: AN ALWAYS-ON CONTEXT-AWARE COMPUTER VISION SYSTEM FOR PORTABLE DEVICES

Speakers:
Swagath Venkataramani, Victor Bahl2, Xian-Sheng Hua2, Jie Liu2, Jin Li2, Matthai Phillipose2, Bodhi Priyantha2 and Mohammed Shoaih2
1Purdue University, US; 2Microsoft Research, US

Abstract
Being aware of objects in the ambient provides a new dimension of context awareness. Towards this goal, we present a system that exploits powerful computer vision algo- rithms in the cloud by collecting data through always-on cameras on portable devices. To reduce communication-energy costs, our system allows client devices to continually analyze streams of video and distill out frames that contain objects of interest. Through a dedicated image-classification engine SAPPHIRE, we show that if an object is found in 5% of all frames, we end up selecting 30% of them to be able to detect the object 90% of the time: 70% data reduction on the client device at a cost of < 60mW of power (45nm ASIC). By doing so, we demonstrate system-level energy reductions of 2X. Thanks to multiple levels of pipelining and parallel vector-reduction stages, SAPPHIRE consumes only 3.0 mJ/frame and 38 ps/OP - estimated to be lower by 11.4X than a 45 nm GPU - and a slightly higher level of peak performance (29 vs. 20 GFLOPS). Further, compared to a parallelized software implementation on a mobile CPU, it provides a processing speed up of up to 235X (1.81 s vs. 7.7 ms/frame), which is necessary to meet the real-time processing needs of an always-on context-aware system.

Download Paper (PDF; Only available from the DATE venue WiFi)
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<tr>
<td>14:30</td>
<td>11.6.2</td>
<td><strong>APPROXIMATE ASSOCIATIVE MEMRISTIVE MEMORY FOR ENERGY-EFFICIENT GPUs</strong></td>
<td>Abbas Rahimi¹, Amirali Ghorbani², Kwang-Ting Cheng³, Luca Benini¹ and Rajesh Gupta¹</td>
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<td><strong>Speakers:</strong></td>
<td>¹UC San Diego, US; ²UC Santa Barbara, US; ³Università di Bologna / Swiss Federal Institute of Technology in Zurich (ETHZ), IT</td>
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<td></td>
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<td><strong>Abstract</strong></td>
<td>Multimedia applications running on thousands of deep and wide pipelines working concurrently in GPUs have been an important target for power minimization both at the architectural and algorithmic levels. At the hardware level, energy-efficiency techniques that employ voltage overscaling face a barrier so-called 'path walls': reducing operating voltage beyond a certain point generates massive number of timing errors that are impractical to tolerate. We propose an architectural innovation, called A2M2 module (approximate associative memristive memory) that exhibits few tolerable timing errors suitable for GPU applications under voltage overscaling. A2M2 is integrated with every floating point unit (FPU), and performs partial functionality of the associated FPU by pre-storing high frequency patterns for computational reuse that avoids overhead due to re-execution. Voltage overscaled A2M2 is designed to match an input search pattern with any of the stored patterns within a Hamming distance range of 0-2. This matching behavior under voltage overscaling leads to a controllable approximate computing for multimedia applications. Our experimental results for the AMD Southern Islands GPU show that four image processing kernels tolerate the mismatches during pattern matching resulting in a PSNR &gt; 30dB. The A2M2 module with 8-row enables 28% voltage overscaling in 45nm technology resulting in 32% average energy saving for the kernels, while delivering an acceptable quality of service.** Download Paper (PDF; Only available from the DATE venue WiFi) **</td>
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<th>15:00</th>
<th>11.6.3</th>
<th><strong>PLATFORM-AWARE DYNAMIC CONFIGURATION SUPPORT FOR EFFICIENT TEXT PROCESSING ON HETEROGENEOUS SYSTEMS</strong></th>
<th>Christian Brugger, Javier Alejandro Varela, Norbert Wehn, Songyin Tang and Ralf Korn, University of Kaiserslautern, DE</th>
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<td><strong>Abstract</strong></td>
<td>Significant efforts have been made in accelerating computer vision and machine learning algorithms by utilizing parallel processors such as multi-core CPUs and GPUs. Although the suitability of GPU is well-known for computer graphics and image processing applications which require massively parallel floating-point computations, recent research movement towards general purpose computing on-GPU (GPGPU) makes it possible to take advantage of parallel processors to accelerate text processing applications as well. However, to fully leverage different types of parallel processor architectures to obtain optimal performance (especially with text) without making specific efforts to each platform still remains a great challenge. We applied performance and accuracy enhancements to Naive Bayes algorithm to develop a practically sound implementation of text classification. A platform-aware dynamic configuration support automation flow is also proposed to support the seamless execution of our work across platforms. Experiments on various (integrated graphics, dedicated multiple GPUs) platforms demonstrate that our proposed approach improves both accuracy and performance of text classification. **Download Paper (PDF; Only available from the DATE venue WiFi) **</td>
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<th>15:15</th>
<th>11.6.4</th>
<th><strong>A DEBLOCKING FILTER HARDWARE ARCHITECTURE FOR THE HIGH EFFICIENCY VIDEO CODING STANDARD</strong></th>
<th>Cláudio Diniz¹, Muhammad Shafique², Felipe Dalín¹, Sergio Bampl¹ and Joerg Henkel²</th>
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<td><strong>Speakers:</strong></td>
<td>¹Federal University of Rio Grande do Sul (UFRGS), BR; ²Karlsruhe Institute of Technology (KIT), DE</td>
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<td><strong>Abstract</strong></td>
<td>The new deblocking filter (DF) tool of the next generation High Efficiency Video Coding (HEVC) standard is one of the most time consuming algorithms in video decoding. In order to achieve real-time performance at low-power consumption, we developed a hardware accelerator for this filter. This paper proposes a high throughput hardware architecture for HEVC deblocking filter employing hardware reuse to accelerate filtering decision units with a low area cost. Our architecture achieves either higher or equivalent throughput (4096x2048 @ 60 fps) with 5X-6X lower area compared to state-of-the-art deblocking filter architectures. **Download Paper (PDF; Only available from the DATE venue WiFi) **</td>
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<tr>
<th>15:30</th>
<th>IPS-15, 176</th>
<th><strong>FASTTREE: A HARDWARE KD-TREE CONSTRUCTION ACCELERATION ENGINE FOR REAL-TIME RAY TRACING</strong></th>
<th>Xingyu Liu, Yangdong Deng, Yufei Ni and Zhonghui Li, Institute of Microelectronics, Tsinghua University, CN</th>
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<td>15, 176</td>
<td><strong>Speakers:</strong></td>
<td>¹Intel Labs, US</td>
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<td><strong>Abstract</strong></td>
<td>The ray tracing algorithm is well-known for its ability to generate photo-realistic rendering effects. Recent years have witnessed a renewed momentum in pushing it to real-time for better user experience. Today the construction of acceleration structures, e.g., kd-tree, has become the bottleneck of ray tracing. A dedicated hardware architecture, FastTree, was proposed for kd-tree construction by adopting a fully parallel construction algorithm. FastTree was validated by an FPGA prototype and evaluated as an ASIC implementation. Experiment result shows FastTree outperforms existing hardware construction engines by a factor of nearly 4X at a similar area and power budget. **Download Paper (PDF; Only available from the DATE venue WiFi) **</td>
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<th>15:31</th>
<th>IPS-16, 688</th>
<th><strong>REVERSE LONGSTAFF-SCHWARTZ AMERICAN OPTION PRICING ON HYBRID CPU/FPGA SYSTEMS</strong></th>
<th>Christian Brugger, Javier Alejandro Varela, Norbert Wehn, Songyin Tang and Ralf Korn, University of Kaiserslautern, DE</th>
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<td>16, 688</td>
<td><strong>Speakers:</strong></td>
<td>¹Intel Labs, US</td>
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<td><strong>Abstract</strong></td>
<td>In today’s markets, high-speed and energy-efficient computations are mandatory in the financial and insurance industry. At the same time, the gradual convergence of high-performance computing with embedded systems is having a huge impact on the design methodologies, where dedicated accelerators are implemented to improve performance and energy efficiency. This paper follows this trend and presents a novel way to price high-dimensional American options using techniques of the embedded community. The proposed architecture targets heterogeneous CPU/FPGA systems, and it exploits the FPGA reconfiguration to deliver high-throughput. With a bit-truth algorithmic transformation based on reconfiguration, it is possible to eliminate the memory bottleneck and access costs. The result is a pricing system that is 16x faster and 268x more energy-efficient than an optimized Intel CPU implementation. **Download Paper (PDF; Only available from the DATE venue WiFi) **</td>
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## Coffee Break in Exhibition Area

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### Lunch Break

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<td><strong>Tuesday, March 10, 2015</strong></td>
<td>Coffee Break 10:30 - 11:30</td>
<td>End of session Coffee Break in Exhibition Area</td>
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<td><strong>Tuesday, March 10, 2015</strong></td>
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<td><strong>Thursday, March 12, 2015</strong></td>
<td>Coffee Break 10:00 - 11:00</td>
<td>Lunch Break 12:30 - 14:00, Keynote lecture from 13:20 - 13:50</td>
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### 11.7 Exploiting Dark Silicon

**Date:** Thursday 12 March 2015  
**Time:** 14:00 - 15:30  
**Location / Room:** Les Bans

**Chair:** Olivier Heron, CEA LIST, FR  
**Co-Chair:** Domenik Helms, OFFIS, DE

The advent of the dark silicon area, raises the need for accurately, yet effectively regarding thermal properties of the system. Employing advanced power gating techniques will additionally raise the achievable gain. Both will be presented in this session.

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| 14:00 | 11.7.1| MATEX: EFFICIENT TRANSIENT AND PEAK TEMPERATURE COMPUTATION FOR COMPACT THERMAL MODELS | Santiago Paganı, Jian-Jia Chen, Muhammad Shafique and Joerg Henkel  
1 Karlsruhe Institute of Technology (KIT), DE;  2TU Dortmund, DE |
|       |       | **Abstract**                                                                        | In many core systems, run-time scheduling decisions, such as task migration, core activations/deactivations, voltage/frequency scaling, etc., are typically used to optimize the resource usages. Such run-time decisions change the power consumption, which can in turn result in transient temperatures much higher than any steady-state scenarios. Therefore, to be thermally safe, it is important to evaluate the transient peaks before making resource management decisions. This paper presents a method for computing these transient peaks in just a few milliseconds, which is suited for run-time usage. This technique works for any compact thermal model consisting in a system of first-order differential equations, for example, RC thermal networks. Instead of using regular numerical methods, our algorithm is based on analytically solving the differential equations using matrix exponentials and linear algebra. This results in a mathematical expression which can easily be analyzed and differentiated to compute the maximum transient temperatures. Moreover, our method can also be used to efficiently compute all transient temperatures for any given time resolution without accuracy losses. We implement our solution as an open-source tool called MatEx. Our experimental evaluations show that the execution time of MatEx for peak temperature computation can be bounded to no more than 2.5 ms for systems with 76 thermal nodes, and to no more than 26.6 ms for systems with 268 thermal nodes, which is three orders of magnitude faster than the state-of-the-art for the same settings. |

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<tr>
<td>14:30</td>
<td>11.7.2</td>
<td>DISTRIBUTED REINFORCEMENT LEARNING FOR POWER LIMITED MANY-CORE SYSTEM PERFORMANCE OPTIMIZATION</td>
<td>Zhuo Chen and Diana Marculescu, Carnegie Mellon University, US</td>
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<tr>
<td></td>
<td></td>
<td><strong>Abstract</strong></td>
<td>As power density emerges as the main constraint for many-core systems, controlling power consumption under the Thermal Design Power (TDP) while maximizing the performance becomes increasingly critical. To dynamically save power, Dynamic Voltage Frequency Scaling (DVFS) techniques have proved to be effective and are widely available commercially. In this paper, we present an On-line Distributed Reinforcement Learning (OD-RL) based DVFS control algorithm for many-core system performance improvement under power constraints. At the finer grain, a per-core Reinforcement Learning (RL) method is used to learn the optimal control policy of the Voltage/Frequency (VF) levels in a system model-free manner. At the coarser grain, an efficient global power budget reallocation algorithm is used to maximize the overall performance. The experiments show that compared to the state-of-the-art algorithms: 1) OD-RL produces up to 98% less budget overshoot, 2) up to 44.3x better throughput per over-the-budget energy and up to 23% higher energy efficiency, and 3) two orders of magnitude speedup over state-of-the-art techniques for systems with hundreds of cores.</td>
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Download Paper (PDF; Only available from the DATE venue WiFi)
Coffee Break 10:00 - 11:00
Lunch Break 10:00 - 11:00
Lunch Break 12:30 - 14:30
Keynote lectures from 12:50 - 14:20 (Room Oisans)
Coffee Break 16:00 - 17:00
Lunch Break 12:30 - 14:20 (Room Oisans)
Coffee Break 15:30 - 16:00
Exhibition Keynote - Designing Systems for the Connected Autonomous Future: An Industry Perspective

Date: Thursday 12 March 2015
Time: 14:00 - 15:00
Location / Room: Salle Lesdiguières

Organiser:
John Zhao, MathWorks, US

Chair:
Jürgen Haase, edacentrum, DE

Moderator:
Paul Smith, MathWorks, US

Will I ever travel in an autonomous vehicle? Will my refrigerator really order food automatically from my grocery store? Can the watch I wear in the future warn me about an impending heart attack? Innovations at the SoC and board level are poised to provide the necessary computational power with low cost and high flexibility to make these products. However, designing the systems of the future -- whether an automobile, connected industrial machinery, medical device, consumer electronics, or an aerospace guidance system -- requires advances not only in embedded systems and software, but how they are designed and verified.

In this keynote, an expert from industry will discuss trends and innovations in systems that are incorporating more electronic content than ever before, and describe model-based development approaches that companies are using to create the system functionality that will power our connected autonomous future.

### UB11 Session 11

Date: Thursday 12 March 2015
Time: 14:30 - 16:30
Location / Room: University Booth, Booth 4, Exhibition Area

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<th>Label</th>
<th>Presentation Title</th>
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COMBINATION OF WSN AND 1ST ORDER KINETIC MODEL FOR REAL-TIME SHELF-LIFE PREDICTION OF PERISHABLE GOODS

Valerio Francesco Annese, Politecnico di Bari, IT

**Abstract**

A complete and autonomous multi-sensing platform for perishable goods monitoring and shelf-life prediction, based on the combination of the wireless sensor network (WSN) technology and a further real-time data processing, is presented. The proposed approach offers an effective solution for waste and losses reduction in the supply chain of perishable products and, thus, an improvement of food safety, as well as food organoleptic qualities: in fact, we demonstrate the possibility to predict products shelf-life from the environmental parameters such as temperature, relative humidity and light exposition in real-time. Although several models for shelf-life prediction have been already developed, none of them was embedded in a complete system supported by the real-time data availability, offered by an "ad hoc" WSN. In our infrastructure, system integration issues are carefully solved: data collected by the WSN are firstly uploaded on a cloud. An appropriate Java application makes these data available to any kind of elaboration. Then, we developed an algorithm that implements a 1st order kinetic model of the quality decay reaction, employed to evaluate remaining shelf-life of the monitored perishable product. The model takes into account the dependence of the degradation rate from the temperature according to Arrhenius law. To validate the platform we have conducted several case studies. Here we propose an 8-days monitoring of a warehouse of vegetable products (fresh tomatoes): the real-time shelf-life prediction was calculate through data coming from six multi-sensing nodes that were monitoring several environmental conditions in which the products were subjected. The implementation of the algorithm in an application for any kind of portable and non-portable devices (just like an iPad, smartphones, etc.) would result in a widespread diffusion of this technology. It is worth to notice that the complete infrastructure is a suitable low-cost and easy to implement solution for monitoring any perishable product (such as beverages, drugs, vaccines, blood, etc.) stored in any environmental condition (warehouse, transportation, store, etc.).

**More information ...**
In this set of tutorial sessions, you will learn the design process improves coverage and test-case generation while reducing the time and resources required. Level design approach enables architectural exploration and partitioning, as well as coordination between SW and HW development workflows. Functional verification throughout environment enables a model-based design workflow for fast prototyping and implementation of the algorithms on heterogeneous embedded targets, such as MPSoC. MATLAB and Simulink provide a rich environment for embedded-system development, with libraries of proven, specialized algorithms ready to use for specific applications. The John Zhao, MathWorks, US

Organiser:
Location / Room:
Time:
Date:
12.8 Tutorial: An Industry Approach to FPGA/ARM System Development and Verification

16:30 End of session

12.8.4 TUTORIAL TOPIC 4: "CONNECTING SIMULINK WITH SYSTEMVERILOG FOR FUNCTIONAL VERIFICATION"
Speaker:
Giorgia Zucchelli, MathWorks, NL
IP5 Interactive Presentations

**Date:** Thursday 12 March 2015  
**Time:** 15:30 - 16:00

Interactive Presentations run simultaneously during a 30-minute slot. A poster associated to the IP paper is on display throughout the morning. Additionally, each IP paper is briefly introduced in a one-minute presentation in a corresponding regular session, prior to the actual Interactive Presentation. At the end of each afternoon Interactive Presentations session the award ‘Best IP of the Day’ is given.

<table>
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<th>Time</th>
<th>Label</th>
<th>Presentation Title</th>
<th>Authors</th>
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<tbody>
<tr>
<td>17:30</td>
<td>End of session</td>
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</table>

**Abstract**

This paper presents a multiport empirical model based on artificial neural network for I/O memory interface (e.g. inverter) designed based on fully depleted silicon on insulator (FDSOI) CMOS 28 nm process for signal and power integrity assessments. The analog mixed-signal identification signals that carry the information about the I/O interface’s nonlinear dynamic behavior are recorded from large signal simulation setup. The model’s functions are extracted based on a nonlinear optimization algorithm and then implemented in Simulink software. The performance of the resulted model is validated in typical power and ground switching noise scenarios. The developed empirical model accurately predicts the timing signal waveforms at the power, ground, and at the output port.

Download Paper (PDF; Only available from the DATE venue WiFi)

**Presentation Title**

**Authors**

**1** Wael Oghais and Jonathan Rodriguez, Instituto de Telecomunicaçôes, PT

**Abstract**

This paper presents a multiport empirical model based on artificial neural network for I/O memory interface (e.g. inverter) designed based on fully depleted silicon on insulator (FDSOI) CMOS 28 nm process for signal and power integrity assessments. The analog mixed-signal identification signals that carry the information about the I/O interface’s nonlinear dynamic behavior are recorded from large signal simulation setup. The model’s functions are extracted based on a nonlinear optimization algorithm and then implemented in Simulink software. The performance of the resulted model is validated in typical power and ground switching noise scenarios. The developed empirical model accurately predicts the timing signal waveforms at the power, ground, and at the output port.

Download Paper (PDF; Only available from the DATE venue WiFi)
IP5-7 LOGICAL EQUIVALENCE CHECKING OF ASYNCHRONOUS CIRCUITS USING COMMERCIAL TOOLS

Speakers: Arash Saffahshahi1, Hsin-Ho Huang2, Priyanka Bhalerao3 and Peter Beere1

Abstract

We propose a method for logical equivalence check (LEC) of asynchronous circuits using commercial synchronous tools. In particular, we verify the equivalence of asynchronous circuits which are modeled at the BSP-level in SystemVerilog as well as circuits modeled at the micro-architectural level using conditional communication library primitives. Our approach is based on a novel three-valued logic model that abstracts the detailed handshaking protocol and is thus agnostic to different gate-level implementations, making it applicable to a variety of different design styles. Our experimental results with commercial LEC tools on a variety of computational blocks and an asynchronous microprocessor demonstrate the applicability and limitations of the proposed approach.

Download Paper (PDF; Only available from the DATE venue WiFi)

IP5-8 MAY-HAPPEN-IN-PARALLEL ANALYSIS OF ELECTRONIC SYSTEM LEVEL MODELS USING UPPAAL MODEL CHECKING

Speakers: Che-Wei Chang and Rainer Doemer, University of California Irvine, US

Abstract

In this paper, we propose an approach for May-Happen-in-Parallel (MHP) analysis of electronic system level (ESL) design which models parallel discrete event simulation with concurrent automation processes and formally identifies those MHP states. Our MHP analysis utilizes formal verification by use of the UPPAAL model checker. The proposed approach converts the system model in SpecC SLDL into an UPPAAL model and generates a set of queries that automatically and completely finds all possible MHP pairs. The experimental results show our approach can report more precise MHP analysis results compared to other works at the cost of extended analysis run time.

Download Paper (PDF; Only available from the DATE venue WiFi)

IP5-9 VERIFYING SYNCHRONOUS REACTIVE SYSTEMS USING LAZY ABSTRACTION

Speakers: Kumar Madhukar1, Mandayam Srivasa2, Bjorn Wachter3, Daniel Kroening3 and Ravindra Metta1

Abstract

Embedded software systems are frequently modeled as a set of synchronous reactive processes. The transitions performed by the processes are given as sequential, atomic code blocks. Most existing verifiers flatten such programs into a global transition system, to be able to apply off-the-shelf verification methods. However, this monolithic approach fails to exploit the lock-step execution of the processes, severely limiting scalability. We present a novel formal verification technique that analyses synchronous concurrency explicitly rather than encoding it. We present a variant of Lazy Abstraction with Interpolants (LAWI), a technique successfully used in circuit verification, and tailor it to synchronous reactive concurrency. We exploit the synchronous communication structure by fixing an execution schedule, circumventing the exponential blow-up of state space caused by simulating synchronous behaviour by means of interleavings. The technique is implemented in SYMPARA, a verification tool for synchronous reactive systems. To evaluate the effectiveness of our technique, we compare SYMPARA with Bounded Model Checking and k-induction, and a LAWI-based verifier for multi-threaded (asynchronous) software. On several realistic examples SYMPARA outperforms the other tools by an order of magnitude.

Download Paper (PDF; Only available from the DATE venue WiFi)

IP5-10 SPINTASTIC: SPIN-BASED STOCHASTIC LOGIC FOR ENERGY-EFFICIENT COMPUTING

Speakers: Rangharajan Venkatesan1, Swagath Venkataramani2, Xuanyao Fong2, Kaushik Roy2 and Anand Raghunathan2

Abstract

Spintronics is one of the leading technologies under consideration for the post-CMOS era. While spintronic memories have demonstrated great promise due to their density, non-volatility and low leakage, efforts to realize spintronic logic have been much less fruitful. Recent studies project the performance and energy efficiency of spintronic logic to be considerably inferior to CMOS. In this work, we explore Stochastic Computing (SC) as a new direction for the realization of energy-efficient logic using spintronic devices. We establish the synergy between stochastic computing and spintronics by demonstrating that (i) the peripheral circuits required for SC to convert to/from stochastic domains, which incur significant energy overheads in CMOS, can be efficiently realized by exploiting the characteristics of spintronic devices, and (ii) the logic complexity and fine-grained parallelism in SC circuits can be leveraged to alleviate the shortcomings of spintronic logic. We propose SPINTASTIC, a new design approach in which all the components of stochastic circuits — stochastic number generators, stochastic arithmetic units, and stochastic-to-binary converters — are realized using spintronic devices. Our experiments on a range of benchmarks from different application domains demonstrate that SPINTASTIC achieves 2.8X improvement in energy over CMOS stochastic implementations and 1.9X over a CMOS binary baseline.

Download Paper (PDF; Only available from the DATE venue WiFi)

IP5-11 LEAKAGE POWER REDUCTION FOR DEEPLY-SCALED FINFET CIRCUITS OPERATING IN MULTIPLE VOLTAGE REGIMES USING FINE-GRAINED GATE-LENGTH BIASING TECHNIQUE

Speakers: Ji Li, Qing Xie, Yanzhi Wang, Shahin Nazarian and Massoud Pedram, University of Southern California, US

Abstract

With the aggressive downsizing of the process technologies and importance of battery-powered systems, reducing leakage power consumption has become one of the most crucial design challenges for IC designers. This paper presents a device-circuit cross-layer framework to utilize fine-grained gate-length biased FinFETs for circuit leakage power reduction in the near- and super-threshold operation regimes. The impacts of Gate-Length Biasing (GLB) on circuit speed and leakage power are first studied using one of the most advanced technology nodes - a 7nm FinFET technology. Then multiple standard cell libraries using different leakage reduction techniques, such as GLB and Dual-VT, are built in multiple operating regimes at this technology node. It is demonstrated that, compared to Dual-VT, GLB is a more suitable technique for the advanced 7nm FinFET technology due to its capability of delivering a finer-grained trade-off between the leakage power and circuit speed, not to mention the lower manufacturing cost. The circuit synthesis results of a variety of ISCAS benchmark circuits using the presented GLB 7nm FinFET cell libraries show up to 70% leakage improvement with zero degradation in circuit speed in the near- and super-threshold regimes, respectively, compared to the standard 7nm FinFET cell library.

Download Paper (PDF; Only available from the DATE venue WiFi)
**IPS-12**

**SUBHUNTER: A HIGH-PERFORMANCE AND SCALABLE SUB-CIRCUIT RECOGNITION METHOD WITH PRüFER-ENCODING**

**Speakers:**
Hong-Yan Su, Chih-Hao Hsu and Yih-Lang Li, National Chiao Tung University, TW

**Abstract**

Sub-circuit recognition (SR) is a problem of recognizing sub-circuits within a given circuit and is a fundamental component in simulation, verification and testing of computer-aided design. The SR problem can be formulated as subgraph isomorphism problem. Performance of previous works is not scalable as the complexities of modern designs increase. In this paper we propose a novel Prüfer-encoding based SR algorithm that performs scalable and high-performance sub-circuit matching. Several techniques including tree structure partition, tree cutting and circuit graph encoding are proposed herein to decompose the SR problem into several small sub-sequence matching problems. A pre-filtering strategy is applied before matching to remove the sub-circuits that are not likely to be matched. A fast branch and bound approach is developed to identify all the sub-circuits within the given circuit. Experimental results show that SubHunter can achieve better performance than SubGemini and detect all the sub-circuits as well. As the circuit size increases, we can also achieve near linear runtime growth that outperforms the exponential growth for SubGemini, showing the scalability of the proposed algorithm.

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**IPS-13**

**TIMING VERIFICATION FOR ADAPTIVE INTEGRATED CIRCUITS**

**Speakers:**
Rohit Kumar1, Bing Li2, Yiren Shen1, Ulf Schlichtmann2 and Jiang Hu1
1Texas A&M University, College Station, US; 2Technische Universität München, DE

**Abstract**

An adaptive circuit can perform built-in self-detection of timing violations and accordingly adjust itself to avoid timing violations. Compared with conventional over-design approach, adaptive circuit design is conceptually advantageous in terms of power-efficiency. Although the advantage has been witnessed in numerous previous works including test chips, adaptive design is far from being widely used in practice. A key reason is the lack of corresponding timing verification support. We develop new timing analysis techniques to fill this void. A main challenge is the large runtime complexity due to numerous adaptivity configurations. We propose several pruning and reduction techniques and apply them in conjunction with statistical static timing analysis (SSTA). The proposed method is validated on benchmark circuits including the recent ISPD’13 suite, which has circuit as large as 150K gates. The results show that our method can achieve orders of magnitude speedup over Monte Carlo simulation with about the same accuracy. It is also several times faster than an exhaustive application of SSTA.

Download Paper (PDF; Only available from the DATE venue WiFi)

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**IPS-14**

**A ROBUST APPROACH FOR PROCESS VARIATION AWARE MASK OPTIMIZATION**

**Speakers:**
Jian Kuang, Wing-Kai Chow and Evangeline Young, The Chinese University of Hong Kong, HK

**Abstract**

As the minimum feature size continues to shrink, whereas the wavelength of light used for lithography remains constant, Resolution Enhancement Techniques are widely used to optimize mask, so as to improve the subwavelength printability. Besides correcting for error between the printed image and target shape, a mask optimization method also needs to consider process variation. In this paper, a robust mask optimization approach is proposed to optimize the process window as well as the Edge Placement Error (EPE) of the printed image. Experiments results on the public benchmarks are encouraging.

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**IPS-15**

**FASTTREE: A HARDWARE KD-TREE CONSTRUCTION ACCELERATION ENGINE FOR REAL-TIME RAY TRACING**

**Speakers:**
Xingyu Liu, Yangdong Deng, Yufei Ni and Zonghui Li, Institute of Microelectronics, Tsinghua University, CN

**Abstract**

The ray tracing algorithm is well-known for its ability to generate photo-realistic rendering effects. Recent years have witnessed a renewed momentum in pushing it to real-time for better user experience. Today the construction of acceleration structures, e.g., kd-tree, has become the bottleneck of ray tracing. A dedicated hardware architecture, FastTree, was proposed for kd-tree construction by adopting a fully parallel construction algorithm. FastTree was validated by an FPGA prototype and evaluated as an ASIC implementation. Experiment result shows FastTree outperforms existing hardware construction engines by a factor of nearly 4X at a similar area and power budget.

Download Paper (PDF; Only available from the DATE venue WiFi)

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**IPS-16**

**REVERSE LONGSTAFF-SCHWARTZ AMERICAN OPTION PRICING ON HYBRID CPU/FPGA SYSTEMS**

**Speakers:**
Christian Brügger, Javier Alejandro Varela, Norbert Wehn, Songyin Tang and Ralf Korn, University of Kaiserslautern, DE

**Abstract**

In today’s markets, high-speed and energy-efficient computations are mandatory in the financial and insurance industry. At the same time, the gradual convergence of high-performance computing with embedded systems is having a huge impact on the design methodologies, where dedicated accelerators are implemented to increase performance and energy efficiency. This paper follows this trend and presents a novel way to price high-dimensional American options using techniques of the embedded community. The proposed architecture targets heterogeneous CPU/FPGA systems, and it exploits the FPGA reconfiguration to deliver high-throughput. With a bit-true algorithmic transformation based on recomputation, it is possible to eliminate the bottleneck and access costs. The result is a pricing system that is 16x faster and 26x more energy-efficient than an optimized Intel CPU implementation.

Download Paper (PDF; Only available from the DATE venue WiFi)

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**IPS-17**

**ACCURATE ELECTROTHERMAL MODELING OF THERMOELECTRIC GENERATORS**

**Speakers:**
Mohammad Javad Dousti1, Antonio Petraglia2 and Massoud Pedram1
1University of Southern California, US; 2Federal University of Rio de Janeiro, BR

**Abstract**

Thermoelectric generators (TEGs) provide a unique way for harvesting thermal energy. These devices are compact, durable, inexpensive, and scalable. Unfortunately, the conversion efficiency of TEGs is low. This requires careful design of energy harvesting systems including the interface circuitry between the TEG module and the load, with the purpose of minimizing power losses. In this paper, it is analytically shown that the traditional approach for estimating the internal resistance of TEGs may result in a significant loss of harvested power. This drawback comes from ignoring the dependence of the electrical behavior of TEGs on their thermal behavior. Accordingly, a systematic method for accurately determining the TEG input resistance is presented. Next, through a case study on automotive TEGs, it is shown that computer-aided design, more than 11% of power losses in the interface circuitry that lies between the TEG and the electrical load can be saved by the proposed modeling technique. In addition, it is demonstrated that the traditional approach would have resulted in a deviation from the target regulated voltage by as much as 59%.

Download Paper (PDF; Only available from the DATE venue WiFi)
12.1 SPECIAL DAY Hot Topic: Technology and Design Platforms for Diagnostics

**Date:** Thursday 12 March 2015  
**Time:** 16:00 - 17:30  
**Location / Room:** Salle Oisans

**Organiser:**  
Jo De Boeck, IMEC, BE

**Chair:**  
Chris Van Hoof, IMEC, BE

**Co-Chair:**  
Minkyu Je, Daegu Gyeongbuk Institute of Science and Technology (DGIST), KR

Key to an efficient and effective treatment is early, fast and precise diagnose. This session showcases some of the recent advances and future potential of technologies that help enable the above mentioned requirements for patient centric care.

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<th>Presentation Title</th>
<th>Authors</th>
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<tr>
<td>16:00</td>
<td>12.1.1</td>
<td>ULTRAFLEXIBLE INTEGRATED CIRCUITS FOR IMPERCEPTIBLE BIO-SENSORS</td>
<td>Teppei Araki, University of Tokyo, JP</td>
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<td><strong>Abstract</strong></td>
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<td>Flexible formfactor is extremely important in medical applications. This presentation demonstrates a 1 micron thick ultraflexible integration platform using thin film transistor technology, and enabling other device integration like OLED and regular diodes and detectors for medical applications like ECG, EMG. Demonstration of this technology in real medical and wearable applications will be given.</td>
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<tr>
<td>16:30</td>
<td>12.1.2</td>
<td>NANOELECTRONICS FOR DISRUPTIVE DIAGNOSTIC PLATFORMS</td>
<td>Liesbet Lagae, IMEC, BE</td>
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<td><strong>Abstract</strong></td>
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<td>Silicon nano-electronics and integrated nano-photonics technology provides an advanced toolbox for disruptive components and systems that will change the way we do diagnostics and therapy outcome monitoring. This enormous potential will be demonstrated by some of the recent developments.</td>
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| 17:00  | 12.1.3| (Best Paper Award Candidate)  
AN ULTRA-LOW POWER DUAL-MODE ECG MONITOR FOR HEALTHCARE AND WELLNESS               | Daniele Bortolotti, Università di Bologna, IT                          |
|        |       | **Abstract**                                                                        |                                                                       |
|        |       | Technology scaling enables today the design of ultra-low cost wireless body sensor networks for wearable biomedical monitors. These devices, according to the application domain, show greatly varying tradeoffs in terms of energy consumption, resources utilization and reconstructed biosignal quality. To achieve minimal energy operation and extend battery life, several aspects must be considered, ranging from signal processing to the technological layers of the architecture. The recently proposed Rakeness-based Compressed Sensing (CS) expands the standard CS paradigm deploying the localization of input signal energy to further increase data compression without sensible RSNR degradation. This improvement can be used either to optimize the usage of a non volatile memory (NVM) to store in the device a record of the biosignal or to minimize the energy consumption for the transmission of the entire signal as well as some of its features. We specialize the sensing stage to achieve signal qualities suitable for both Healthcare (HC) and Wellness (WN), according to an external input (e.g. the patient). In this paper we envision a dual-operation wearable ECG monitor, considering a multi-core DSP for input biosignal compression and different technologies for either transmission or local storage. The experimental results show the effectiveness of the Rakeness approach (up to = 70%) more energy efficient than the baseline) and evaluate the energy gains considering different use case scenarios. | Daniele Bortolotti, Università di Bologna, Italy; Andrea Bartolini, Riccardo Rovatti, Gianluca Setti and Luca Benini |

**End of session**

17:30

12.2 Solver Advances and Emerging Applications

**Date:** Thursday 12 March 2015  
**Time:** 16:00 - 17:30  
**Location / Room:** Belle Etoile

**Chair:**  
Julien Schmaltz, Eindhoven University of Technology, NL

**Co-Chair:**  
Gianpiero Cabodi, Politecnico di Torino, IT

The first three papers of this session present strong advances to the scalability of Boolean and arithmetic solvers.
PROBABILISTIC MODEL CHECKING

A UNIVERSAL MACRO BLOCK MAPPING SCHEME FOR ARITHMETIC CIRCUITS

SOLVING DQBF THROUGH QUANTIFIER ELIMINATION

FORMAL VERIFICATION OF SEQUENTIAL GALOIS FIELD ARITHMETIC CIRCUITS USING ALGEBRAIC GEOMETRY

TOWARDS AN ACCURATE RELIABILITY, AVAILABILITY AND MAINTAINABILITY ANALYSIS APPROACH FOR SATELLITE SYSTEMS BASED ON PROBABILISTIC MODEL CHECKING

12.3 Patterning, Pairing, Placement and Packing

Date: Thursday 12 March 2015
Time: 16:00 - 17:30
Location / Room: Stendhal

Chair: Dirk Strosbandt, Ghent University, BE
Co-Chair: Patrick Groeneveld, Synopsys, US

Place-and-route remain at the core of physical design, but must address a variety of important objectives, constraints and concerns. They can be added by standard-cell design to improve routing congestion while keeping area small.
MODELS FOR DETERMINISTIC EXECUTION OF REAL-TIME MULTIPROCESSOR APPLICATIONS

**Speakers:**
- Peter Poplavko
- Dario Socci
- Paraskevas Bourgos
- Marius Bozga
- Saddek Bensalem

**Abstract**

With the proliferation of multi-cores in embedded real-time systems, many industrial applications are being (re-)targeted to multiprocessor platforms. However, exactly reproducible data values at the outputs as function of the data and timing of the inputs is less trivial to realize in multiprocessors, while it can be imperative for various practical reasons. Also for parallel platforms it is harder to evaluate the task utilization and ensure schedulability, especially for end-to-end communication timing constraints and aperiodic events. Based upon reactive system extensions of Kahn process networks, we propose a model of computation that employs synchronous events and event priority relations to ensure deterministic execution. For this model, we propose an online scheduling policy and establish a link to a well-developed scheduling theory. We also implement this model in publicly available prototype tools and evaluate them on state-of-the-art multi-core hardware, with a streaming benchmark and an avionics case study.

Download Paper (PDF; Only available from the DATE venue WiFi)
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<tr>
<td>16:30</td>
<td>12.4.2</td>
<td>PRE-SIMULATION SYMBOLIC ANALYSIS OF SYNCHRONIZATION ISSUES BETWEEN DISCRETE EVENT AND TIMED DATA FLOW MODELS OF COMPUTATION</td>
<td>Liliana Andreadi¹, Torsten Maehe¹, Alain Vachoux², Cédric Ben Aoun¹, François Pecheux¹ and Marie-Minerve Louerat³</td>
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<tr>
<td></td>
<td></td>
<td><strong>Abstract</strong></td>
<td>The SystemCAMS extensions support heterogeneous modeling and make use of several Models of Computation (MoCs) that operate on different time scales in the Discrete Event (DE), Discrete Time (DT), and Continuous Time (CT) domains. The simulation of such heterogeneous models may raise synchronization problems that are hard to diagnose and to fix, especially when considering multi-rate data flow parts. In this paper, we show how to formally analyze the execution of Timed Data Flow (TDF) models including their interaction with the DE domain by converting the synchronization mechanics into a Coloured Petri Net (CPN) equivalent. The developed symbolic execution algorithm for the CPN allows to detect all DE-TDF synchronization issues before simulation and to propose appropriate sample delay settings for the TDF converter ports to make the system schedulable. The presented technique is validated with a case study including a vibration sensor model and its digital front end. Download Paper (PDF; Only available from the DATE venue WiFi)</td>
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<tr>
<td>17:00</td>
<td>12.4.3</td>
<td>FORMAL CONSISTENCY CHECKING OVER SPECIFICATIONS IN NATURAL LANGUAGES</td>
<td>Rongjie Yan¹, Chih-Hong Cheng² and Yesheng Chai³</td>
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<td></td>
<td></td>
<td><strong>Abstract</strong></td>
<td>Early stages of system development involve outlining desired features such as functionality, availability, or usability. Specifications are derived from these features that concretize vague ideas presented in natural languages. The challenge for the verification and validation of specifications arises from the syntax and semantic gap between different representations and the need of automatic tools. In this paper, we present a requirement-consistency maintenance framework to produce consistent representations. The first part is the automatic translation from natural languages describing functionalities to formal logic with an abstraction of time. It extends pure syntactic parsing by adding semantic reasoning and the support of partitioning input and output variables. The second part is the use of synthesis techniques to examine if the requirements are consistent in terms of realizability. When the process fails, the formulas that cause the inconsistency are reported to locate the problem. Download Paper (PDF; Only available from the DATE venue WiFi)</td>
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<td>17:30</td>
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<td>End of session</td>
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**12.5 New Perspectives in Next-Generation Medical Systems**

**Date:** Thursday 12 March 2015  
**Time:** 16:00 - 17:30  
**Location / Room:** Meije

**Chair:**  
Martin Rajman, École Polytechnique Fédérale de Lausanne (EPFL), CH

**Co-Chair:**  
Giovanni De Micheli, École Polytechnique Fédérale de Lausanne (EPFL), CH

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<th>Time</th>
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<th>Presentation Title</th>
<th>Authors</th>
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<tr>
<td>16:00</td>
<td>12.5.1</td>
<td>TACKLING THE BOTTLENECK OF DELAY TABLES IN 3D ULTRASOUND IMAGING</td>
<td>Aya Ibrahim¹, Pascal Hager², Andrea Bartolini³, Federico Angeloni¹, Marcel Ardití², Luca Benini³ and Giovanni De Micheli¹</td>
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<td></td>
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<td><strong>Abstract</strong></td>
<td>3D ultrasound imaging is quickly becoming a reference technique for high-quality, accurate, expressive diagnostic medical imaging. Unfortunately, its computation requirements are huge and, today, demand expensive, power-hungry, bulky processing resources. A key bottleneck is the receive beamforming operation, which requires the application of many permutations of fine-grained delays along the digitized received echoes. To apply these delays in the digital domain, in principle large tables (billions of coefficients) are needed, and the access bandwidth to these tables can reach multiple TB/s, meaning that their storage both on-chip and off-chip is impractical. However, smarter implementations of the delay generation function, including forgoing the tables altogether, are possible. In this paper we explore efficient strategies to compute the delay function that controls the reconstruction of the image, and present a feasibility analysis for an FPGA platform. Download Paper (PDF; Only available from the DATE venue WiFi)</td>
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<td>16:30</td>
<td>12.5.2</td>
<td>INTEGRATED CMOS RECEIVER FOR WEARABLE COIL ARRAYS IN MRI APPLICATIONS</td>
<td>Benjamin Sporrer¹, Luca Bettini², Christian Vogt², Andreas Mehmmann³, Jonas Reber³, Josip Marjanovic³, Thomas Burger³, David Brunner³, Gerhard Tröster³, Klaus P. Prüssmann³ and Quting Huang²</td>
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<td><strong>Abstract</strong></td>
<td>Surface coil arrays brought in proximity of the human body enhance the performance of an MRI measurement both in speed and signal-to-noise ratio. However, size and cabling of such arrays can deteriorate the performance of the imaging, or put at risk the safety of the patient. An integrated CMOS direct conversion receiver is proposed, to be placed directly onto the receive coil and enhance the usability. The integrated design needs to preserve the high performance (both in silent noise figure and dynamic range) of discrete solutions, which benefit from dedicated technologies for every receiver sub-block. To exploit the full potential of a coil array, the receiver on each module must also minimize the coupling to nearby modules. The PCB carrying the ASIC will be fabricated with flexible substrate materials to further enhance the wearability and comfort for the patient. Such a modular approach together with the transmission of data over optical fibers results in a lightweight system that allows us to achieve fast development times. Download Paper (PDF; Only available from the DATE venue WiFi)</td>
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<td>17:00</td>
<td>12.5.3</td>
<td>TACTILE PROSTHETICS IN WISESKIN</td>
<td>John Farserotou¹, Jean-Dominique Decotignie¹, Vladimir Kopta¹, Daniel Camilo Rojas Quirós¹, Pierre-Nicolas Volpe¹, Jacek Babrowiski¹, Christian Enz², Stéphanie Lacour¹, Hadrien Mauch², Roberto Martuzzi², Volker Koch³, Huaqi Huang³, Tao Li³ and Christian Antfolk⁴</td>
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<td><strong>Abstract</strong></td>
<td>Tactile prosthetics promise to revolutionize the treatment of amputees. However, the development of new tactile sensors is a significant challenge, as current technology relies on rigid, bulky, and uncomfortable devices. In this paper, we present a novel approach for the design of flexible, biocompatible tactile sensors that can be integrated into prosthetic devices. The sensors are fabricated using a novel 3D printing technique that allows for the creation of high-resolution, compliant structures. The sensors are tested in a variety of conditions to evaluate their performance, and the results show that they are capable of accurately detecting pressure and providing haptic feedback. The use of these sensors in prosthetics has the potential to improve the functionality and comfort of current prosthetic designs. Download Paper (PDF; Only available from the DATE venue WiFi)</td>
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### 12.6 Medical Design Automation: Is All That Simulation and Model Reduction Getting Into Your "Head"?

**Date:** Thursday 12 March 2015  
**Time:** 16:00 - 17:30  
**Location / Room:** Bayard

**Organisers:**  
Luis Miguel Silveira, INESC-ID, PT  
Luca Daniel, MIT, US

**Chair:**  
Luca Daniel, MIT, US  
**Co-Chair:**  
Luis Miguel Silveira, INESC-ID, PT

Tools and techniques originally developed by the Electronic Design Automation community for parasitic extraction, model reduction, or circuit simulation are having deep impact in alternative and exiting fields outside of the circuit world. In particular, this session shows several applications of such techniques to analyzing the functionality of the brain and of the nervous system, as well aiding the design of biomedical and medical instrumentation and diagnostics.

#### 12.6.1 THE OLD, THE NEW, AND THE RECYCLED - EDA ALGORITHMS IN CONNECTOMIC

**Speaker:**  
Lou Scheffer, Howard Hughes Medical Institute, US

**Abstract**  
Connectomics seeks to extract detailed wiring diagrams of circuits of the nervous system. This makes it a combination of reverse engineering (as applied to chips), parasitic extraction, and model reduction. As biologists extract and work with the larger neural circuits that can now be extracted, they are running into many of the same problems that EDA faced long ago. This talk compares and contrasts connectomics with the equivalent processes for chips, notes the differences and similarities, and shows where algorithms developed for EDA can help connectomics.

#### 12.6.2 COMPUTATIONAL MODELING AND SIMULATION OF SYNCHRONIZED FIRING BEHAVIORS OF THE BRAIN

**Speaker:**  
Peng Li, Texas A&M, US

**Abstract**  
Computational simulation is a critical enabler for understanding complex functions and neuronal dynamics of mammalian brains. However, several grant challenges, such as retaining biological realism in computer-based models, obtaining and managing a vast amount of biological data, and tackling high computational complexity, exist. Nevertheless, efficient computational techniques, capable of simulating large neural networks with biophysically accurate neuron models, are highly desirable. Such capability will fundamentally enable the test of hypotheses of neurological disorders and development of therapeutic treatments, as well as stimulate new engineering applications. In this talk, we will show how neuronal models of different complexities (behavioral oscillator models vs. Hodgkin-Huxley models) and global connectivity data may be leveraged to reason about the origins of oscillatory behaviors of the brain. The key focus of the talk will be placed on a large-scale biophysically detailed thalamocortical model and parallel numerical techniques that have been developed to efficiently handle widely spread time scales in the network. Our results suggest that computational technologies may shed light on the causes of absence seizures by associating abnormal brain level oscillation with several key cellular level mechanisms.

#### 12.6.3 ELECTROMAGNETIC POWER DEPOSITION ANALYSIS TOOL FOR HIGH RESOLUTION MAGNETIC RESONANCE IMAGING BRAIN SCANS

**Speakers:**  
Jorge F. Villena¹, Athanasios G. Polimeridis¹, Lawrence L. Wald¹, Elfar Adalsteinsson¹, Jakob K. White¹ and Luca Daniel¹  
¹Massachusetts Institute of Technology, US; ²Massachusetts General Hospital, Harvard Medical School, US

**Abstract**  
MARIE (MAgnetic Resonance Integral Equation suite) is an open domain numerical software platform for fast electromagnetic (EM) analysis and design of Magnetic Resonance Imagine (MRI) scanners. The tool is based on a combination of surface and volume integral equation formulations. It exploits the characteristics of the different parts of an MRI system (coil array, shield and realistic body model), and it applies sophisticated numerical methods to rapidly perform all the required EM simulations to characterize the MRI design: computing the untuned coil port parameters; obtaining the current distribution for the tuned coils, and the corresponding electromagnetic field distribution in the inhomogeneous body for each transmit channel. The software runs on MATLAB and is able to solve a complex scattering problem in ~2-3 min. on a standard single GPU-accelerated windows desktop machine. On the same platform it can perform a frequency sweep of a complex coil in ~3-5 min. per frequency point. Furthermore, it can solve the complete inhomogeneous body and coil system in ~3-10 min. per port, depending on the model resolution and error tolerance required. The software could potentially be employed also on more advanced analyses, such as the generation of ultimate intrinsic Signal to Noise Ration (SNR) and Specific Absorption Rare (SAR) on realistic body models, fast coil design and optimization, and generation of patient specific protocols.

**Time**  
17:30  
**End of session**
### 16:00 12.7.1 TOWARDS A QUANTITATIVE MEASUREMENT OF MENTAL DISORDERS

**Speaker:** Jordi Aguiló, CIBER-BBN, Centro Nacional de Microeléctronica, Universitat Autònoma de Barcelona, ES

**Abstract**

The population of Europe is aging at an unprecedented speed as the result of declining reproduction rates and increasing life expectancy. Today, chronic diseases are the main cause of illness in old age but mental disorders such as dementia and late-life depression play also a significant role as well as epilepsy and Alzheimer. Besides, because of the constant pressure the modern way of life imposes on the individuals, stress is also dramatically growing-up to point that the World Health Organization called it a World Wide Epidemic. In particular, the number of patients with dementia is expected to rise sharply as the prevalence of dementia doubles every 5.2 years exponentially between 65 and 85 years of age [3]. Late-life depression is also an important public health problem. Estimated 1-year prevalence rates for depression range from 3% to 10% [6]. For dementia, prevalence rates are estimated between 0.6% and 3.7% for 65 to 69 year olds and 25.2% to 75% for adults 90 years old or older. Additionally, multiple studies have shown high comorbidity between mental disorders and chronic physical illnesses in the elderly. Positive feedback has also been demonstrated between different diseases such as diabetes mellitus, cancer and cardiovascular disease and the occurrence of depression in the elderly. And vice-versa, in older populations there is also a positive feedback between depression and hypertension, diabetes and cardiovascular illnesses. Although the relationship between some biomarkers and mental or acute physical disorders has been known for a long time, due to the complexity of etiology of mental disorders none of them have been considered as gold standard reference. Recently, novel indicators such as the heart rate variability, respiratory abnormalities, neuropeptide Y (NPY) as well as inflammation biomarkers such as interleukin-6 or TNF-a has been proposed. In parallel, computing power has dramatically increased whilst technically and economically viable, non-invasive, reliable and efficient sensors are becoming usable. Taking advantage of these advances, multiparametric markers can be elaborated putting together these constellations of symptoms and indicators. These new multiparametric biomarkers will probably allow a quantitative assessment of the severity of mental disorders. In this session, we will review etiology, the most relevant symptoms, the recent results and a summary of the roadmap for mental health research in Europe; the new trends on using electrophysiological signals to evaluate psychophysiological states as well as the contribution of new nanomaterials in the setup of new Micro-Nano-Bio Systems for diagnosis of mental disorders.

### 16:15 12.7.2 IMPROVING THE MONITORING AND THE UNDERSTANDING OF MENTAL DISORDERS

**Speakers:** Giovanni de Girolamo¹ and Josep Maria Haro²

¹IRCCS Fatebenefratelli, IT; ²Parc Sanitari Sant Joan de Deu, ES

**Abstract**

Classification and diagnosis of mental disorders is nowadays based on a descriptive taxonomy and is still lacking of biological markers. Devices and techniques coming from new technologies will allow real-time assessment of selected neurophysiological patterns will open the way to a new understanding of mental disorders, making possible new strategies on assessment of patients. In this presentation we will critically discuss these developments.

### 16:40 12.7.3 WORLD ANALYSIS OF NON-INVASIVE CARDIOVASCULAR SIGNALS FOR THE MONITORING OF PSYCHOPHYSIOLOGICAL STATES

**Speakers:** Michele Orini¹ and Pablo Laguna²

¹Institute of Cardiovascular Science, University College London, GB; ²CIBER-BBN, ES

**Abstract**

The recent advances in biomedical electronics are paving the road to a new paradigm in health care. Stress and some mental disorders are related to the cardiovascular function in such a way that ECG signals can be used to continuously monitoring the psychophysiological state of patients. We review these methodologies within the new context.

### 17:05 12.7.4 HEALTHCARE IN AN INTEGRATED DIGITAL WORLD

**Speaker:** Arben Merkoçi, Catalan Institution for Research and Advanced Studies (ICREA) and Institut Català de Nanociència i Nanotecnologia (ICN2), ES

**Abstract**

Example designs of nanomaterials-based biosystems related to various clinical biomarkers including neurodegenerative disease will be shown. The developed devices and strategies are intended to be of low cost while offering high analytical performance in screening diagnostic scenarios.

### 17:30 End of session

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