



Concordia
UNIVERSITY





Hardware Verification Group: Introduction

Prof. Sofiene Tahar

Department of
Electrical and Computer Engineering
Concordia University
Montreal, Quebec, CANADA

Concordia University

- Among top 10 Universities in Canada
- 40,000 students (undergraduate and graduate)
- 4 Faculties:
 - Arts and Science
 - Fine Arts
 - Business
 - **Engineering**
- Faculty of Engineering
 - 5000 students
 - 3500 Undergraduate
 - 1500 Graduate (Masters and PhD) ⇒ **LARGEST in CANADA**
 - 150 faculty members
 - 4 Departments
 - **Electrical and Computer Engineering**
 - Mechanical and Industrial Engineering
 - Civil, Building and Environment Engineering
 - Computer Science

ECE Department

- Programs:
 - Electrical Engineering (Options: VLSI, Telecom)
 - Computer Engineering (Options: Hardware, Software)
- Student Population:
 - ELEC Ugrad: 546
 - COEN Ugrad: 342
 - M.Eng.: 272
 - M.A.Sc.: 195
 - Ph.D.: 156 ⇒ **TOTAL: 351**
- Faculty and Staff:
 - 39 full-time faculty members
 - 12 technical and support staff
- Laboratories:
 - 34 Teaching Labs (Hall building)
 - 47 Research Labs (EV Building)

ECE Research Clusters

- **Systems and Control**

- # faculty members: 4
- # graduate students: 36
- # laboratories: 5

- **Electromagnetics**

- # faculty members: 3
- # graduate students: 19
- # laboratories: 6

- **Microdevices and Fabrication**

- # faculty members: 2
- # graduate students: 16
- # laboratories: 6

- **Power Electronics:**

- # faculty members: 2
- # graduate students: 8
- # laboratories: 2

ECE Research Clusters

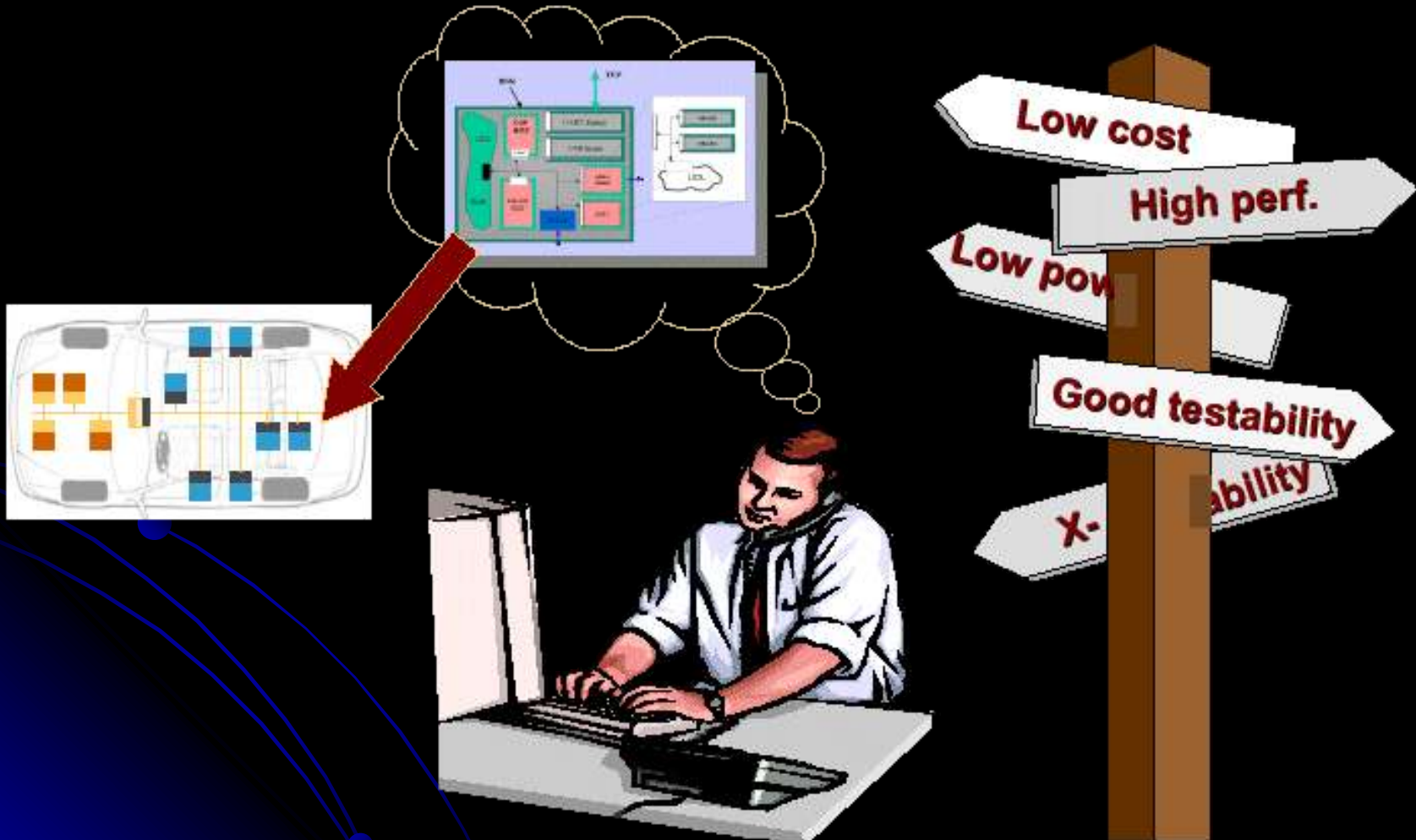
- **Telecommunications**
 - # faculty members: 11
 - # graduate students: 59
 - # laboratories: 7
- **Digital Signal Processing**
 - # faculty members: 8
 - # graduate students: 61
 - # laboratories: 6
- **VLSI/Microelectronics**
 - # faculty members: 4
 - # graduate students: 19
 - # laboratories: 4
- **Computer Software**
 - # faculty members: 5
 - # graduate students: 26
 - # laboratories: 5
- **Computer Hardware**
 - # faculty members: 2
 - # graduate students: 23
 - # laboratories: 3



Design of Electronics Systems



Design Challenges



Design Errors



Floating-point division bug

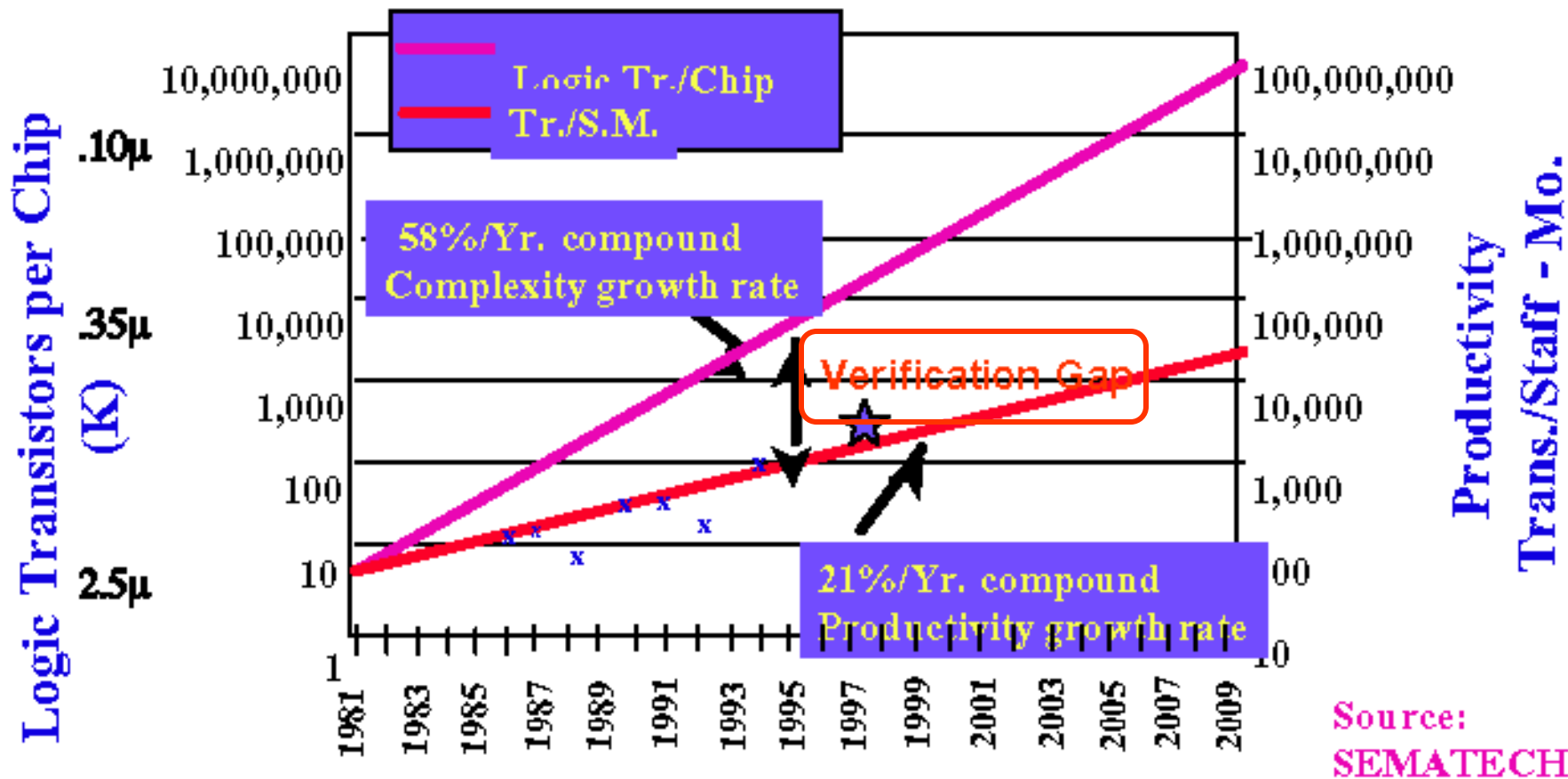


Patriot Missile Failure, a classical case of rounding error



Floating-point to Integer conversion

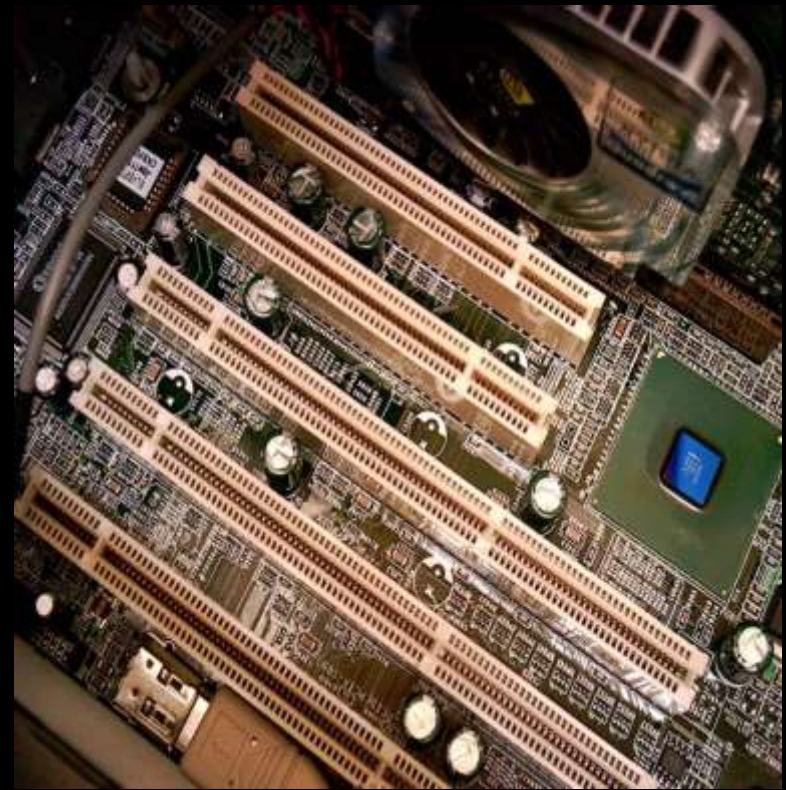
Verification Gap



The situation is **worsening** as **technology evolves**

Design Verification

- Verification accounts for **60-70%** of project cost (human, computing and time)
- Increasing VLSI technology and design **complexity** (1.7 billion transistors on chip)
- Traditional **simulation** limited to a tiny percentage of test cases
- Situation is most serious for **safety critical** applications



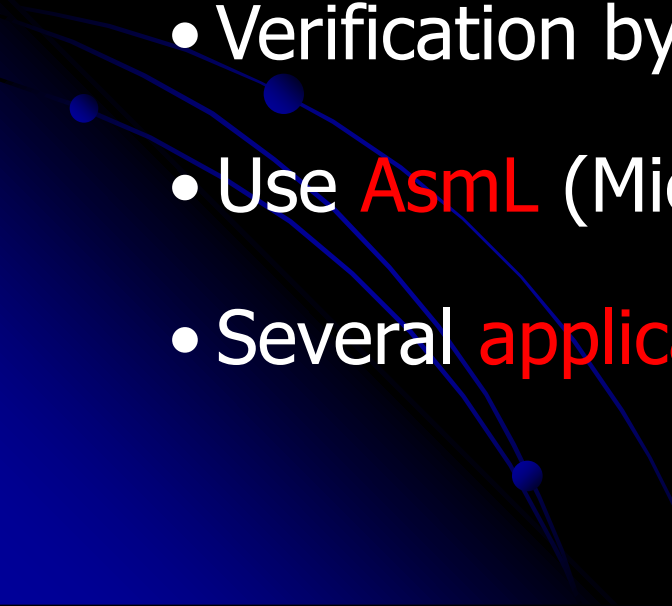
In HVG lab, we focus on **formal verification** as complement to simulation techniques

Who are we?

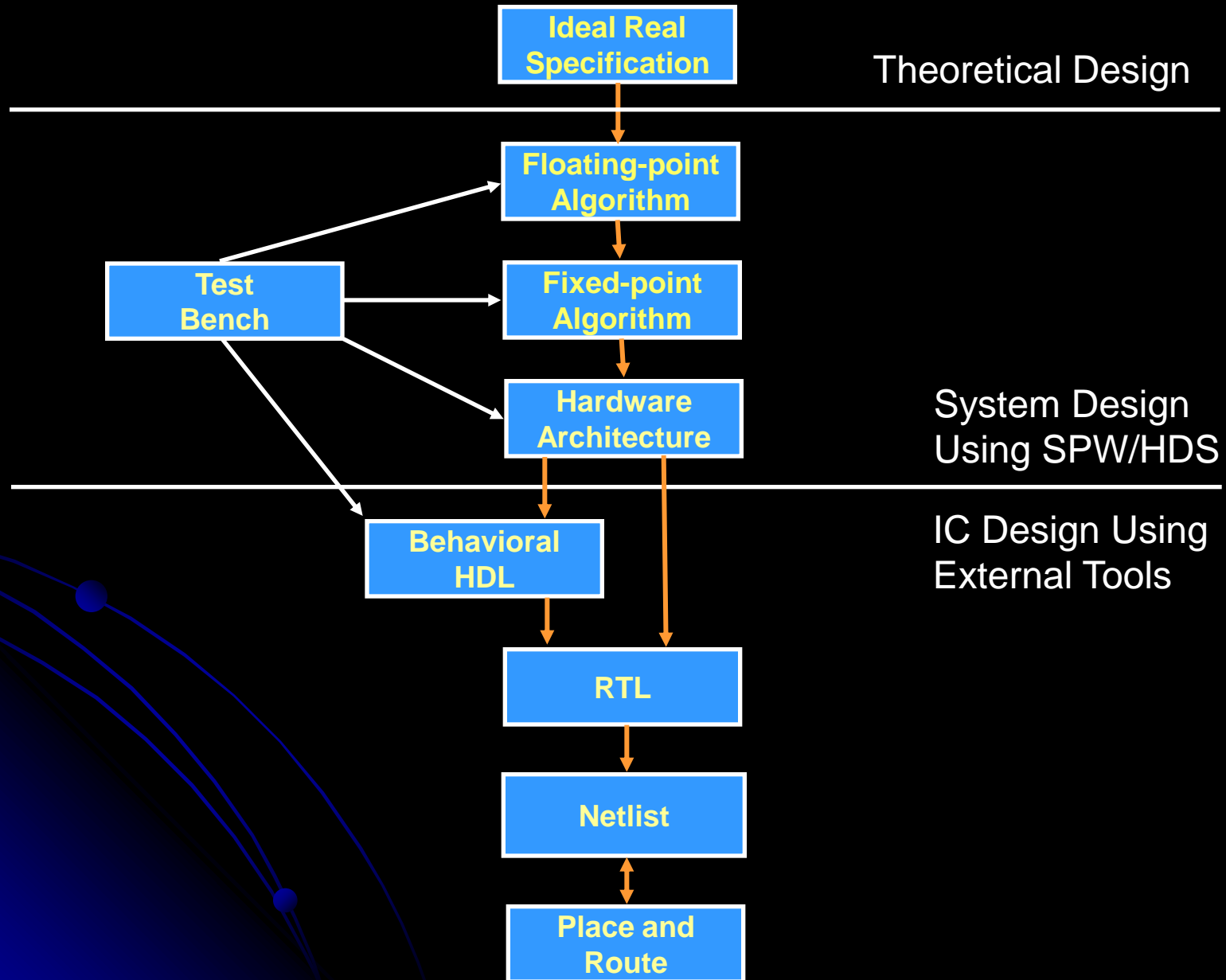
- **Hardware Verification Group (HVG)** founded in 1996 by Prof. Sofiene Tahar
- Recognized as University **Research Unit** in 2007
- **Mission:** develop Methodologies, Algorithms and Tools for Formal Verification of Hardware and Embedded Systems
- Currently composed of 25 researchers

Faculty	Postdoc	PhD	Master's
3	2	11	9

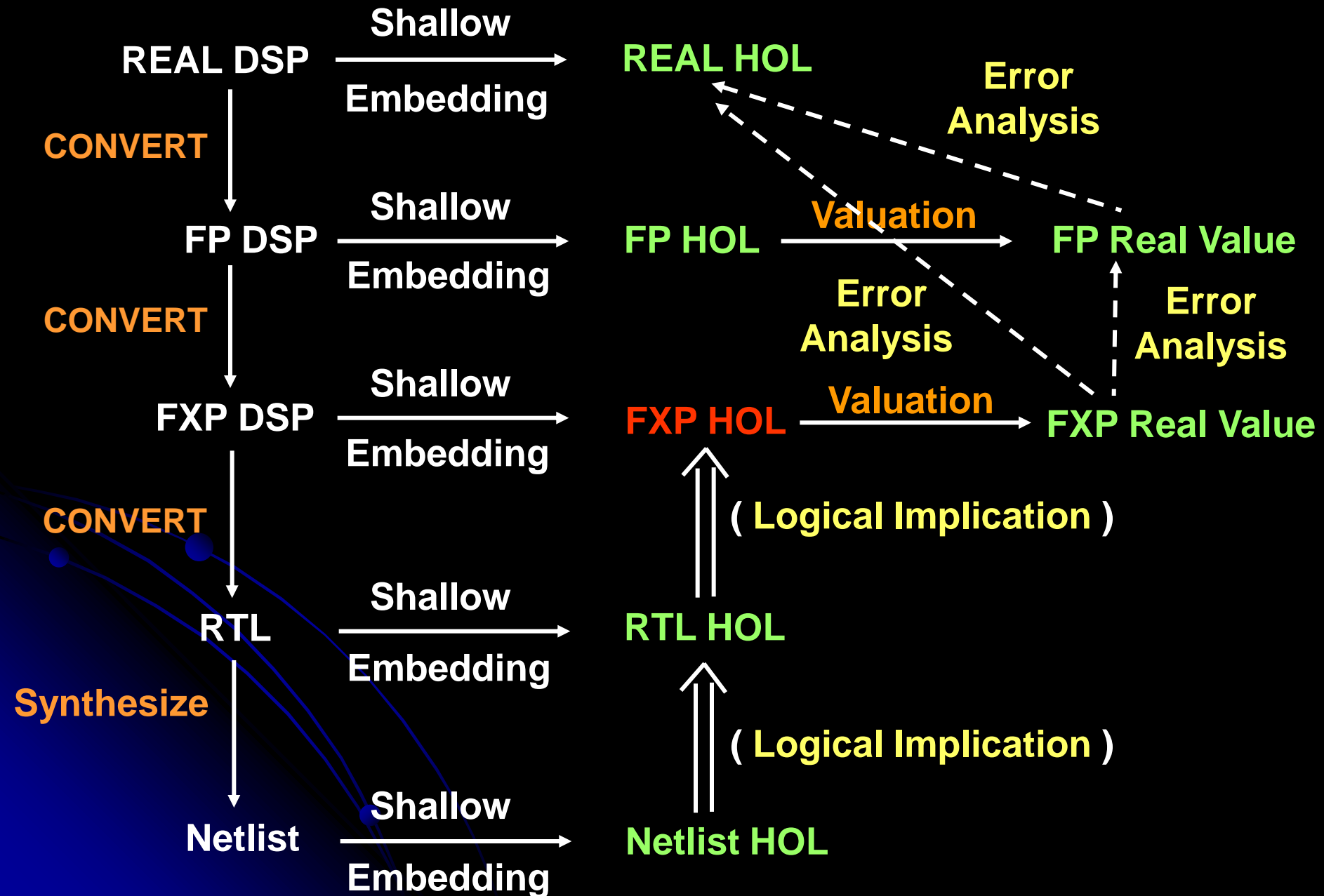
SystemC Verification

- Designs in **SystemC**
 - High level modeling in **UML**
 - Properties and Assertions in **PSL**
 - Verification by **Model Checking** and **ABV**
 - Use **AsmL** (Microsoft) as intermediate language
 - Several **applications**
- 

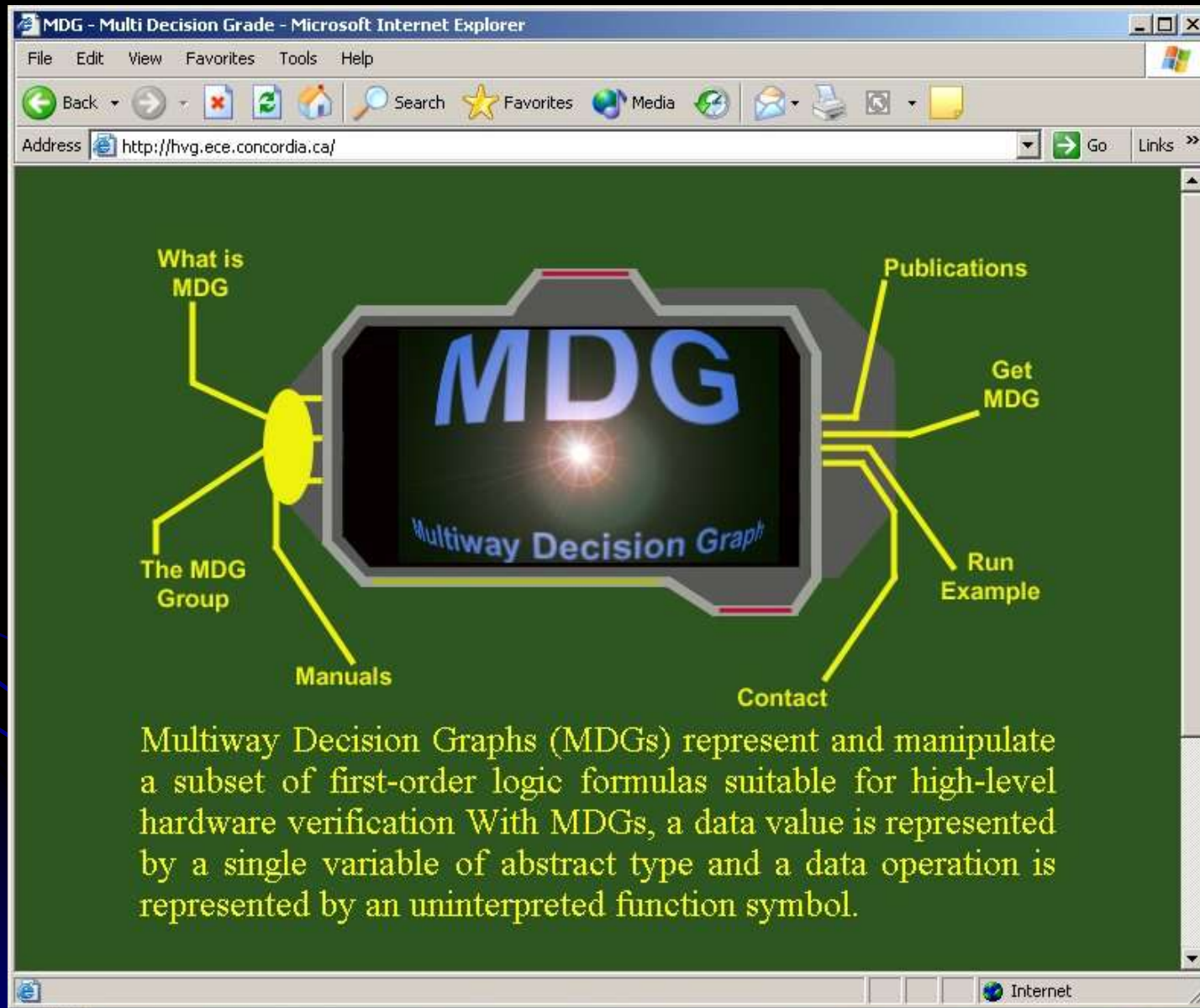
DSP Design Flow



DSP Verification Methodology



Tools Development



What is MDG

The MDG Group

Manuals

Publications

Get MDG

Run Example

Contact

MDG
Multiway Decision Graph

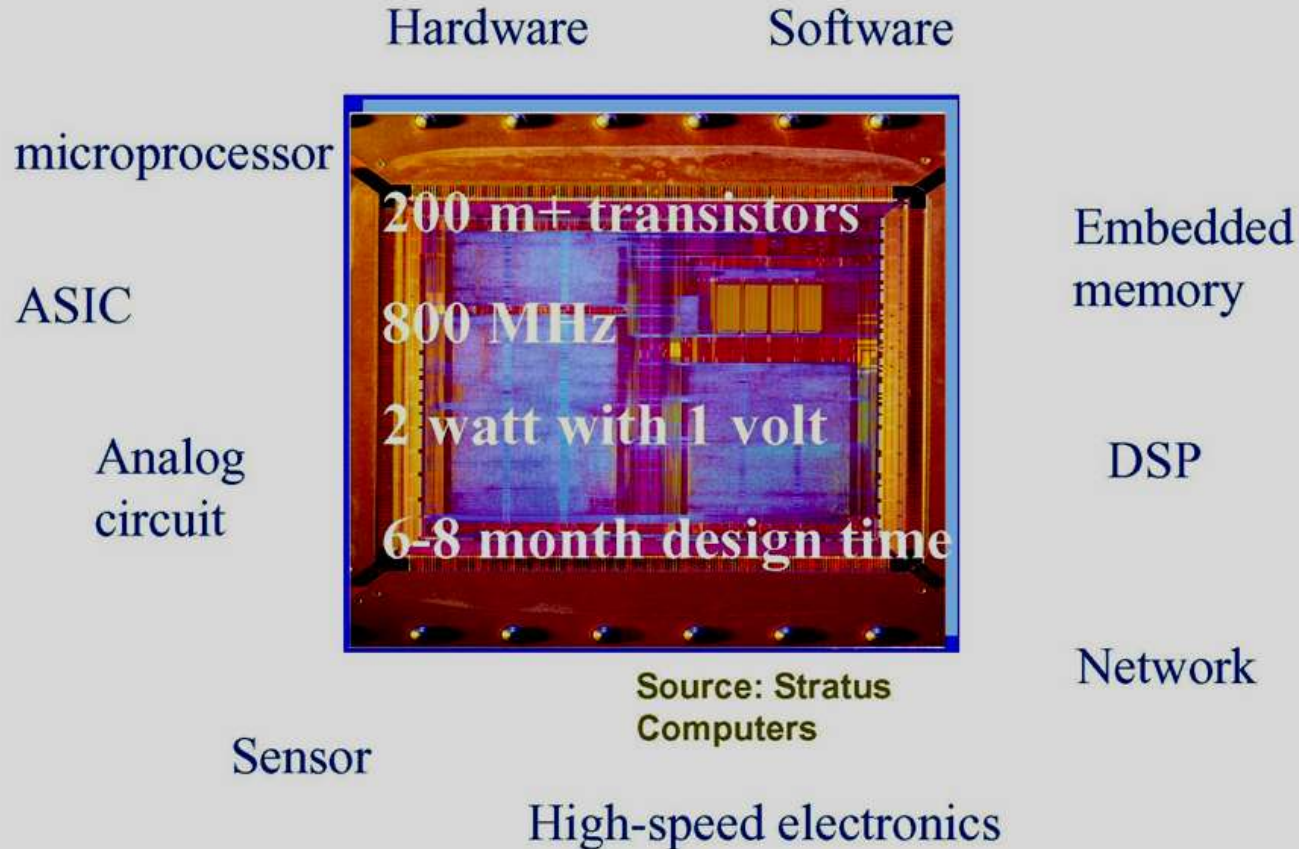
Multiway Decision Graphs (MDGs) represent and manipulate a subset of first-order logic formulas suitable for high-level hardware verification. With MDGs, a data value is represented by a single variable of abstract type and a data operation is represented by an uninterpreted function symbol.

Applications (in collaboration with Industry)

- Digital Signal Processors verification using HOL (**Analog Devices**).
- ATM switch verification (**Nortel Networks**).
- SONET Protocol verification using MDG (**PMC-Sierra**)
- Telecom block system verification using FormalCheck (**PMC-Sierra**).
- Formal Verification of IEEE FPU using HOL (**Intel**).
- Cryptographic protocols verification (**SRI**).
- WiMax modem verification (**STMicroelectronics**)
- Mobile network load and content testing (**Ericsson**)
-

Next 10 years....

System on Chip (SoC)



Open Research Projects

System-on-a-Chip Verification

Verification of **Probabilistic Systems**

Verification of Security Systems

Verification of **Analog and Mixed Signal Systems**

• **Verification of **Optical** Systems**

Multiway Decision Graphs

Verification Applications (with industry**)**

Research Funding



M I C R O N E T R & D

Fonds de recherche
sur la nature
et les technologies

Québec



Développement
économique, Innovation
et Exportation

Québec



RESMIQ

Regroupement Stratégique
en Microélectronique du Québec

North American



User's Group



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Industrial Partners



STMicroelectronics

ERICSSON 



PMC
PMC-SIERRA

NORTEL

Amirix



SYNOPSYS®



MIPS
TECHNOLOGIES



TEXAS
INSTRUMENTS



Academic Partners



University of Oxford

Université de Montréal



HVG Stars: Behzad Akbarpour


CONCORDIA'S THURSDAY REPORT VOL. 29, NO.17 JUNE 2, 2005


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Previous story: Oscar Verter has a passion for nature nurtured in B.C.

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 **Concordia UNIVERSITY**
Real education for the real world

 Great Grads 2005


Behzad Akbarpour's thesis could save lives

BY LINA SHOUMAROVA

Behzad Akbarpour hopes his doctoral dissertation in electrical engineering will help prevent costly and sometimes fatal errors in hardware and software systems.

"We are very much dependent on such systems for continuous operation," he said. "Unfortunately, it is no longer feasible to shut down a malfunctioning system in order to restore safety."

In case of an error, cars, airplanes, electronic commerce, telephone switching networks and computerized medical instruments can be affected. In order to prevent failure, Behzad has developed a methodology for verification of the design and functioning of digital signal processing systems.



First time in Concordia history

- 2006 Best Engineering PhD in Canada
- 2006 Best PhD in Engineering and Sciences in Quebec
- 2006 Faculty Best PhD Thesis Award
- Research Assoc. at Cambridge University, UK

HVG Stars: Amr Abdel-Hamid

Our engineers change the world!

After completing both his MASc and PhD in Electrical Engineering ('01-'06) at Concordia University, Amr was recruited as an Assistant Professor of Computer Engineering at West Virginia University in the USA. Amr conducts his research on security and hardware verification, with a focus on building tools needed for building new generations of "independent components" (IC).

Along with focusing on his academic success at Concordia, Amr also became actively involved in student government. He was elected president of the Engineering and Computer Science Graduate Association which enabled him to develop and hone his communication and leadership skills; as well as work with a wide network of members in the Concordia community including professors, students, and staff. Amr also found the time to enjoy the vibrant student life that Concordia has to offer in the beautiful city of Montreal.

"Concordia has an excellent electrical engineering program. The multi-disciplinary education I received shaped my future and most importantly my personality"

Amr T. Abdel-Hamid, PhD.

"Here's why I chose the Faculty of Engineering & Computer Science."

- Leading-edge teaching and research facilities
- Innovative range of multi-disciplinary programs
- Hands-on experience
- Educational opportunities with industrial partnerships
- Accomplished professors and researchers
- Team-oriented learning environment
- Outstanding student life and activities

For admission requirements, please visit our website at: <http://www.concordia.ca/>



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HVG Stars: Osman Hasan



First time in HVG history

- PhD Thesis ranked in **2008 First in Engineering** and **second in University**
- Named **Valedictorian** for the **graduating class of 2008**.
- Ph.D. Thesis published as a **Book by the German VDM Publisher**
- **Work interested NASA!!**
- Assistant Professor at **SEECs, NUST, Pakistan**

HVG Home Page



Hardware Verification Group
Concordia University

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WELCOME TO THE **NEW** HVG WEBSITE

HVG (Hardware Verification Group) is one of the several research labs in the department of [Electrical and Computer Engineering in Concordia University](#)



HVG mission is the development of methodologies, algorithms and tools for the formal and semi-formal verification of hardware and embedded systems.

HVG was founded in 1996 by [Prof. Sofène Tahar](#) and is currently composed of more than 25 [members](#)

HVG conducted several projects in collaboration with [national and international industry and academic partners](#).

HVG research is funded by various [national granting agencies](#) and sponsored by several [local and international industries](#).

Quick Links

- [Conference CFPs](#)
- [Technical Reports](#)

TPHOLS 2008 HVG will be hosting the 21st International Conference on Theorem Proving in Higher Order Logics (TPHOLS 2008).
[TPHOLS 2008 Host Selection](#) [Concordia's Bid](#)

HVG is the host of the [North American SystemC User's Group](#)

HVG IN THE NEWS

2007 Research Fellow !

Prof. Sofène Tahar received the «2007 Concordia University Research Award». Prof. Tahar was honored in the Senior/Established category.



[Read More](#)

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Faculté de génie

Management
Informatique, Automatique
et Électronique
Québec

SYSTEMC

ST

CAE

ERICSSON

PMC
PMC-SIERRA

NORTEL

GREAT BEHZAD !!



Dr. Behzad Akbarpour is a former HVG member. He received numerous awards

- [«Canada NSERC Doctoral Award»](#)
- [«Quebec ADESAQ prix d'excellence»](#)
- [«Concordia Great Grad 2005»](#)
- [«Faculty of Engineering Best PhD Thesis Awards»](#)

Dr. Behzad Akbarpour is now a research associate at [Cambridge University](#)

[Read About Behzad](#)

[News Releases](#)

"Our Engineers Change The World !"

Dr. Amr Abdel-Hamid is a former HVG member

Dr. Amr Abdel-Hamid is now an assistant professor at [The German University in Cairo](#)



Our engineers change the world!

Read About HVG

- [Winter 2007 "Can he check your \(micro\) chip?"](#)
- [Spring 2005 "HVG - ECE's Electronic Dream Team"](#)
- [Feb 2005 "Significant Innovations 2004-2005"](#)
- [Fall 2004 "Concordia Group helps Pioneer... System-on-Chip Research"](#)

[Read more](#)

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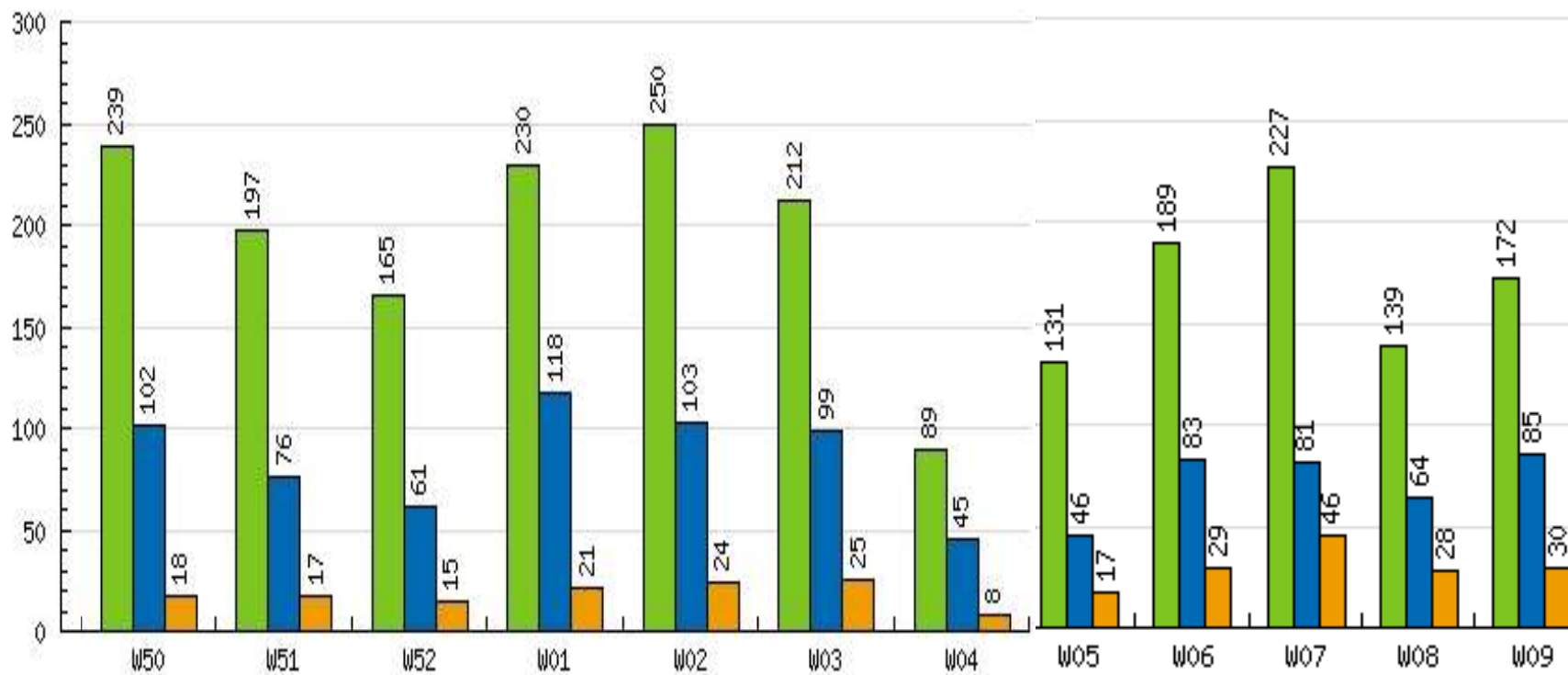
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HVG Global Visibility

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<http://hvg.ece.concordia.ca/>

21st
 International
 Conference on
 Theorem
 Proving in
 Higher-order
 Logics and
 Applications

TPHOL'08
 Montreal, August 2008

Sponsors



Conference chair: *Sofiene Tahar, Concordia University*

Program co-chairs: *Otmane Ait Mohamed, Concordia University*
Cesar Munoz, NASA, Virginia, USA

ICCD 2009

OCTOBER 4 — 7 2009, Resort at Squaw Creek, Lake Tahoe, California
XXVII IEEE INTERNATIONAL CONFERENCE ON COMPUTER DESIGN

Sponsorship (pending) by
IEEE Computer Society, IEEE Circuits and Systems Society and IEEE Electron Devices Society

CALL FOR PAPERS IMPORTANT DATES Submission: May 8 Notification: July 24 Camera-Ready: August 23

<http://www.iccd-conference.org>

The International Conference on Computer Design encompasses a wide range of topics in the research, design, and implementation of computer systems and their components. ICCD's multi-disciplinary emphasis provides an ideal environment for developers and researchers to discuss practical and theoretical work covering system and computer architecture, verification and test, design and technology, and tools and methodologies.

The theme for the 2009 ICCD conference is:

- Disruptive Computer Design -

Unprecedented economic, ecological, and social forces are impacting computer designers this year, and revolutionary, disruptive, new ideas are urgently required to respond to global, transformational changes. What will it take for you to design a low-power computing system that is ecologically-friendly, minimizes total cost of ownership, and opens new areas of application?

Submitted papers consistent with this theme are encouraged, but manuscripts describing original work on any topic from the scope of ICCD are welcome. Authors are asked to submit technical papers in accordance to the author's instructions in one of the following five conference tracks:

Computer Systems: Methods, Implementations, and Applications

Advanced computer architecture for general and application-specific enhancement. System design methods for uni- and parallel processors. Design methods for homogeneous and heterogeneous multi-core processor systems and system-on-chip designs. IP and platform-based designs. HW/SW-Codesign. Modeling and performance analysis. Support for security, languages and operating systems. Smart Cards. Real-time Systems. Application-specific and embedded software optimization. Optimizing and parallelizing compiler support for multithreaded and multi-core designs. Memory system and Network system optimization.

Processor Architecture. Microarchitecture design techniques for uni- and multi-core processors: instruction-level parallelism, pipelining, caching, branch prediction, multithreading, computer arithmetic. Techniques for low-power, secure, and reliable processor designs. Embedded, network, graphic, system-on-chip, application-specific and digital signal processor design; real-life design challenges: case studies, tradeoffs and post-mortems.

Logic and Circuit Design. Circuits and design techniques for digital, memory, analog and mixed-signal systems. Circuits and design techniques for high performance and low power. Circuits and design techniques for robustness under process variability and radiation. Design techniques for emerging process technologies (MEMs, spintronics, nano, quantum). Asynchronous circuits. Signal processing and arithmetic circuits, and circuits for graphic processor design.

Electronic Design Automation. High-level, logic and physical synthesis. Physical planning, design and early estimation for large circuits. Automatic analysis and optimization of timing, power and noise. Tools for multiple-clock domains, asynchronous and mixed timing methodologies. CAD support for FPGAs, ASSPs, structured ASICs, platform-based design and networks-on-chip, DIM and OPC methodologies. Tools, methodologies and design strategies for emerging technologies (MEMs, spintronics, nano, quantum).

Verification and Test. Functional, transaction-level, RTL, and gate-level modeling and verification of hardware designs. Simulation-based and formal techniques for functional design verification. Dynamic simulation, equivalence checking, formal verification, model and property checking, and theorem proving. High-level design validation; hardware emulation, modeling languages, assertion-based verification, coverage-analysis, constrained-random test generation; design error debug and diagnosis; Hardware/Software validation; Fault modeling; Fault simulation and ATPG; Fault tolerance; DFT and BIST; SoC verification.



ICCD 2009 TRACK CHAIRS

- Computer Systems**
Greg Byrd, North Carolina State University
Michael Gschwind, IBM Corporation
- Processor Architecture**
Jim Bondi, Texas Instruments
Eren Kursun, IBM Corporation
- Logic and Circuit Design**
Guy Even, Tel Aviv University
Lars Svensson, Chalmers University of Tech
- Electronic Design Automation**
Farzan Fallah, Ervis Corporation
Jörg Henkel, University of Karlsruhe
- Verification and Test**
Sule Ozev, Arizona State University
Klaus Schneider, University of Kaiserslautern



OCTOBER 3 — 6 2010, Mövenpick Conference Center, Amsterdam, the Netherlands
XXVIII IEEE INTERNATIONAL CONFERENCE ON COMPUTER DESIGN

ICCD 2010

Sponsorship (pending) by
IEEE Computer Society, IEEE Circuits and Systems Society and IEEE Electron Devices Society

Call for Papers Important Dates Submission: May 7 (abstract) Notification: July 23 Camera-Ready: August 23

<http://www.iccd-conference.com>

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The theme for the 2010 ICCD conference is:

- Embedded Systems -

Submitted papers consistent with this theme are encouraged, but manuscripts describing original work on any topic from the scope of ICCD are welcome. Authors are asked to submit technical papers in accordance to the author's instructions in one of the following five conference tracks:

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Processor Architecture. Microarchitecture design techniques for uni- and multi-core processors: instruction-level parallelism, pipelining, caching, branch prediction, multithreading, computer arithmetic. Techniques for low-power, secure, and reliable processor designs. Embedded, network, graphic, system-on-chip, application-specific and digital signal processor design; real-life design challenges: case studies, tradeoffs and post-mortems.

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Electronic Design Automation. High-level, logic and physical synthesis. Physical planning, design and early estimation for large circuits. Automatic analysis and optimization of timing, power and noise. Tools for multiple-clock domains, asynchronous and mixed timing methodologies. CAD support for FPGAs, ASSPs, structured ASICs, platform-based design and networks-on-chip, DIM and OPC methodologies. Tools, methodologies and design strategies for emerging technologies (MEMs, spintronics, nano, quantum).

Verification and Test. Functional, transaction-level, RTL, and gate-level modeling and verification of hardware designs. Simulation-based and formal techniques for functional design verification. Dynamic simulation, equivalence checking, formal verification, model and property checking, and theorem proving. High-level design validation; hardware emulation, modeling languages, assertion-based verification, coverage-analysis, constrained-random test generation; design error debug and diagnosis; Hardware/Software validation; Fault modeling; Fault simulation and ATPG; Fault tolerance; DFT and BIST; SoC verification.

ICCD 2010 ORGANIZING COMMITTEE

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Carlo Galuzzi, TU Delft and Ioannis Sourdis, TU Delft



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- Electronic Design Automation**
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- Verification and Test**
Sule Ozev, Arizona State University
Klaus Schneider, University of Kaiserslautern



For more information please refer to:

<http://hvg.ece.concordia.ca/>

For any further details, please send your questions and comments to:

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Thanks!

