

IEEE 
rebooting
COMPUTING



Circuits & Systems Society

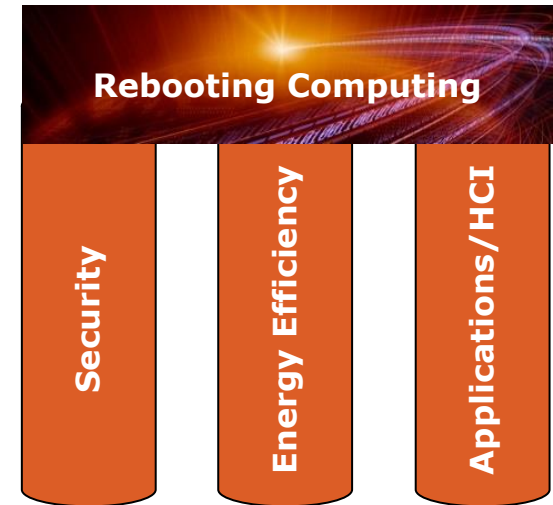


IEEE Rebooting Computing

- **Initiative of IEEE (FDC) – 9 Societies/Councils**
 - Bold Vision of the Future of Computing - Holistic Rethinking
 - Integration of Approaches – IEEE as catalyst of change
 - Complementary to other initiatives
 - Input from user community
 - Pre-Competitive and Inclusive
 - No preconceptions; agendas; start with a clean slate
- **Web portal <http://rebootingcomputing.ieee.org>**

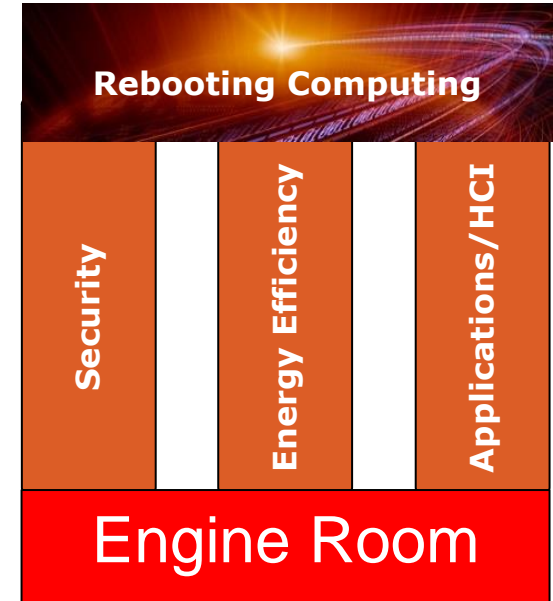
IEEE Rebooting Computing

- **Reports and Publications**
- **Meetings/Workshops/Conferences**
 - **Summit 1:** 2013 Dec. 12-13 (summary online)
Three Pillars:
Energy Efficiency, Security, Applications/HCI
 - **Summit 2:** 2014 May 14-16 (summary online)
Engines of Computation
 - Augmentation of CMOS
 - Approximate Computing
 - Neuromorphic Computing
 - Adiabatic/Reversible Computing
 - **Summit 3:** 2014 Oct. 23-24
Algorithms and Architecture
 - Security
 - Human-Computer Interactions
 - Randomness and Approximate Computing
 - Parallellism
 - **2015 and Beyond:** workshops and conferences



IEEE Rebooting Computing

- **Reports and Publications**
- **Meetings/Workshops/Conferences**
 - **Summit 1:** 2013 Dec. 12-13 (summary online)
Three Pillars:
Energy Efficiency, Security, Applications/HCI
 - **Summit 2:** 2014 May 14-16 (summary online)
Engines of Computation
 - Augmentation of CMOS
 - Approximate Computing
 - Neuromorphic Computing
 - Adiabatic/Reversible Computing
 - **Summit 3:** 2014 Oct. 23-24
Algorithms and Architecture
 - Security
 - Human-Computer Interactions
 - Randomness and Approximate Computing
 - Parallellism
 - **2015 and Beyond:** workshops and conferences



IEEE Rebooting Computing – RCS1

- The First Summit – RCS1 – 2013 December 12-13
- A different approach to crystallize a vision and develop a plan
- “Appreciative Inquiry,” professionally guided
- 3 Pillars: Applications/HCI, Security, Energy Efficiency
- “Measures of Success” to track and assess progress
- Government, Industry, Academia
- Represented Institutions include:

Government and Related: *DARPA, IARPA, NSF, DOE, NSA, SRC, LPS, White House OSTP, Sandia, LLNL*

Industry: *IBM, Intel, Microsoft, HP, Hypres, Micron, Google, NVIDIA*

University: *Georgia Tech, Stony Brook U., USC, GMU, Stanford U., U. of Texas/Austin, U. of Illinois/Urb.-Ch, UCSD, UC-Berkeley, Purdue U., U. Toronto, D. R&D Canada, U-Penn, U. Chicago*

Summary of RCS1 at <http://rebootingcomputing.ieee.org/RCS1.pdf>

IEEE Rebooting Computing – RCS1

■ Bob Colwell – DARPA MTO

- End of Moore’s Law, commoditization, but opportunities in:
- Software, Security, Energy Efficiency, Human Interfaces, Internet of Things, Real problem applications, deal with “taken for granted”

■ Peter Highnam – IARPA

- High-risk/high-payoff research: principled, measurable outcomes, open
- Superconducting, Quantum, Cryogenic memory, Trusted IC, Neuromorphic computing, Accurate forecasting

■ Rob Leland – OSTP

- 1940 “boot up”/von Neumann: major advance + tech. opportunity + urgency
- Now: Moore’s Law + Big Data + International Competition + ?

■ David McQueeney – IBM

- New era of cognitive computing, exponential growth in big data → towards 10^{23}
- Grand challenges for focus and inspiration; opportunities in cybersecurity, cancer treatment, education; collaboration in a new computing ecosystem

IEEE Rebooting Computing – RCS1 Vision 2023+

- Energy Efficiency / Efficiency / Sustainability
 - “Proportional” energy consumption, seamless charging, seamless syncing, full sustainability, energy harvesting, Data Centers + zones of data and energy connectivity + end/terminal devices
- Security
 - The computer will act in the person’s best interest
- Applications/HCI
 - “Aug-mentor”
 - “Intelligent” interactions, understanding language, proposing and implementing solutions: the perfect assistant

IEEE Rebooting Computing – RCS2

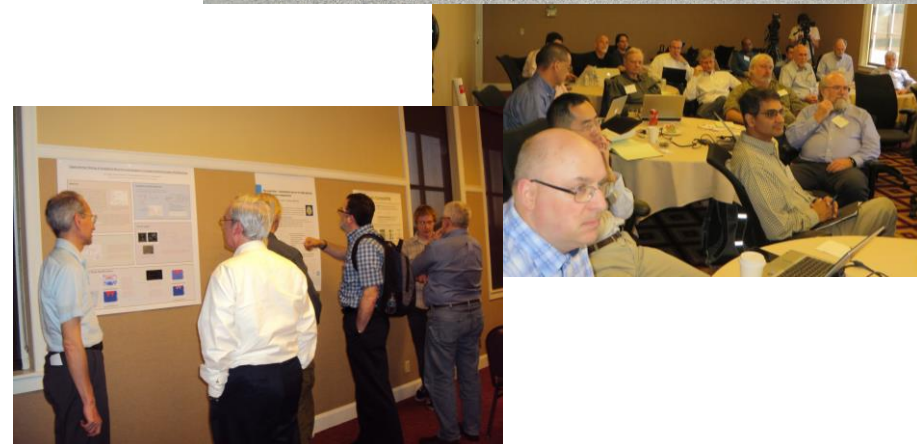
Achieving the vision Engines of Computation

May 14-16, 2014 at The Chaminade, Santa Cruz, CA
48 invited participants who are thought leaders
from government agencies, academia, and
industry

Built on 2013 Rebooting Computing Summit
(RCS 1)

Plenary talks and discussion centered on
four computing technologies :

- Augmentation of CMOS
 - Approximate Computing
 - Adiabatic and Reversible Computing
 - Neuromorphic Computing
- Poster Presentations/Session



Summary of RCS2 at

<http://sites.ieee.org/rcsummit/files/2014/07/RCS2ReportFinal.pdf>

IEEE Rebooting Computing – RCS2 Highlights

- Todd Hylton (Brain Corp.) – Neuromorphic Computing
 - Distinction: architecture and algorithms – cannot expect brain-like performance
- Subu Iyer (IBM) – Augmentation of CMOS
 - It's economics! Room for mining applications and parallelism
- David Frank (IBM) – Adiabatic/Reversible Computing
 - Exploring fundamental low-energy limits of computation – continuing promise
- Hadi Esmaeilzadeh (Georgia Tech.) – Approximate Computing
 - Efficiency through approximations – promising approach but must be careful
- Andrew Kahng (UCSD) – ITRS 2.0
 - Focus on applications; pull on system level vs. push on device level; cost constraints; computing ubiquity in mobile systems
- Mark Stalzer – XPRIZE
- Yung-Hsiang Lu (Purdue U.) – RC competition
- Scott Holmes – (BAH) – The Heilmeyer Questions

Competition for Low-Power Image Recognition

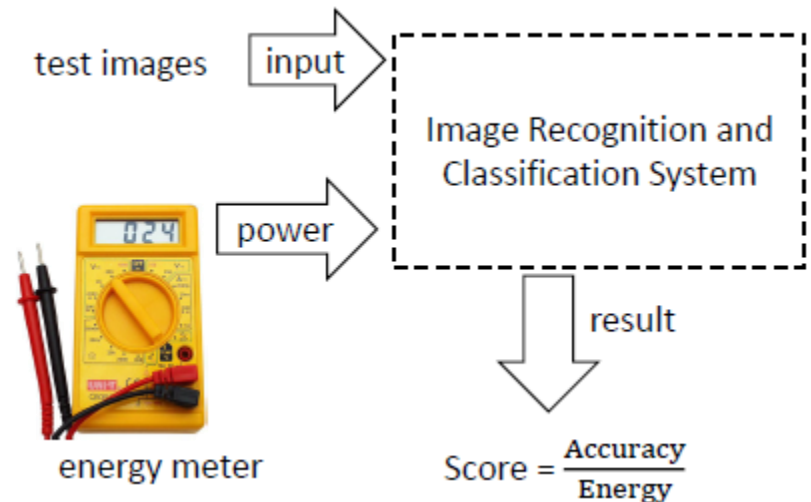
Yung-Hsiang Lu and Alex Berg
Purdue and UNC

Mobile Image Acquisition Energy Conservation

- Many people have multiple mobile systems that can capture videos or images
- Mobile robots use cameras for sensing and navigation
- Sending raw video data over wireless network is too expensive
- Video processing on mobile systems desirable



- Fall 2014 – release ILSVRC *training* data and demo code for low-power visual detection competition (LPVDC) evaluation
- Fall 2014 – collect and label new *test* data for the low-power visual detection competition (LPVDC)



- June 2015 – LPVDC held in DAC 2015
 - Compute devices will contact networked server for test images
 - Output will be submitted to server for evaluation
 - Time limit of 1 hour ~100-200 images processed (on a laptop with GPU)
 - Live results + leaderboard
- Participants need to register for DAC (~\$150)

IEEE RCS2

Emerging path:

Rather than “siloes” approaches, there is not only unity of purpose in the different engines, but much commonality of methods → will there be a unique, composite solution?

IEEE Rebooting Computing – RCS3 Organizing Committee

- Tom Conte, Co-Chair
- Erik DeBenedictis
- Paolo Gargini
- Bichlien Hoang
- Scott Holmes
- Alan Kadin
- Yung-Hsiang Lu
- David Mountain
- Elie Track, Co-Chair
- Dillian Waldron

IEEE Rebooting Computing – RCS3

Key Rule

**Leave your agendas
at the door**

IEEE Rebooting Computing – RCS3

Achieving the Vision

Algorithms / Architecture

- Algorithms / Architecture
 - Parallelism
 - Security
 - Randomness and Approximate Computing
 - Human-Computer Interactions

- Identify:
 - Roadmaps
 - Milestones
 - Grand challenges
 - Programs (R&D and prototyping)