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](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

2014 October 23-24
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

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

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)
Emerging path:

Rather than “siloed” 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
  - Parallellism
  - Security
  - Randomness and Approximate Computing
  - Human-Computer Interactions

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