

IEEE 
rebooting
COMPUTING

Summit #4

10-11 December 2015

Washington Hilton





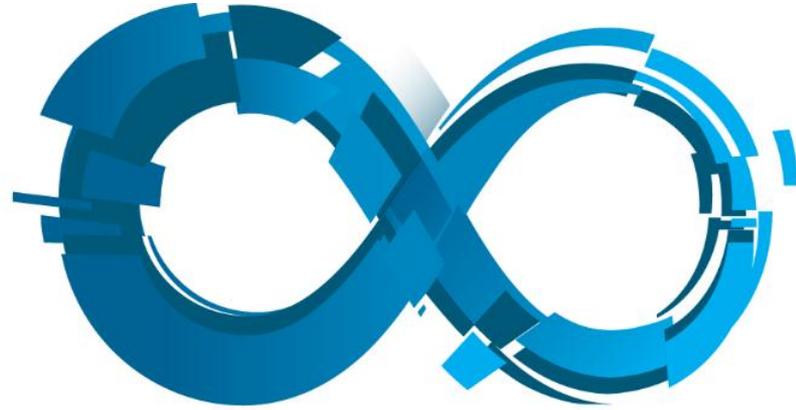
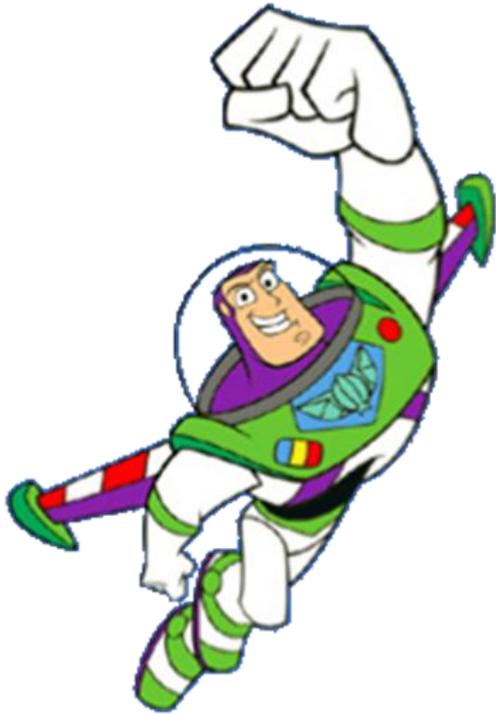
Rethink Everything: Turing & Von Neumann to now



Circuits & Systems Society



Summit Chairs - Erik DeBenedictis & David Mountain **RC Chairs** - Tom Conte & Elie Track **Posters** - Neal Anderson, **ITRS 2.0** - Paolo Gargini, **IEEE** - Bichlien Hoang & Alan Kadin **LPIRC** - Yung-Hsiang Lu, **RC Committee** - Scott Holmes, Arvind Kumar, Jesse Beu



**TO INFINITY
AND BEYOND!**

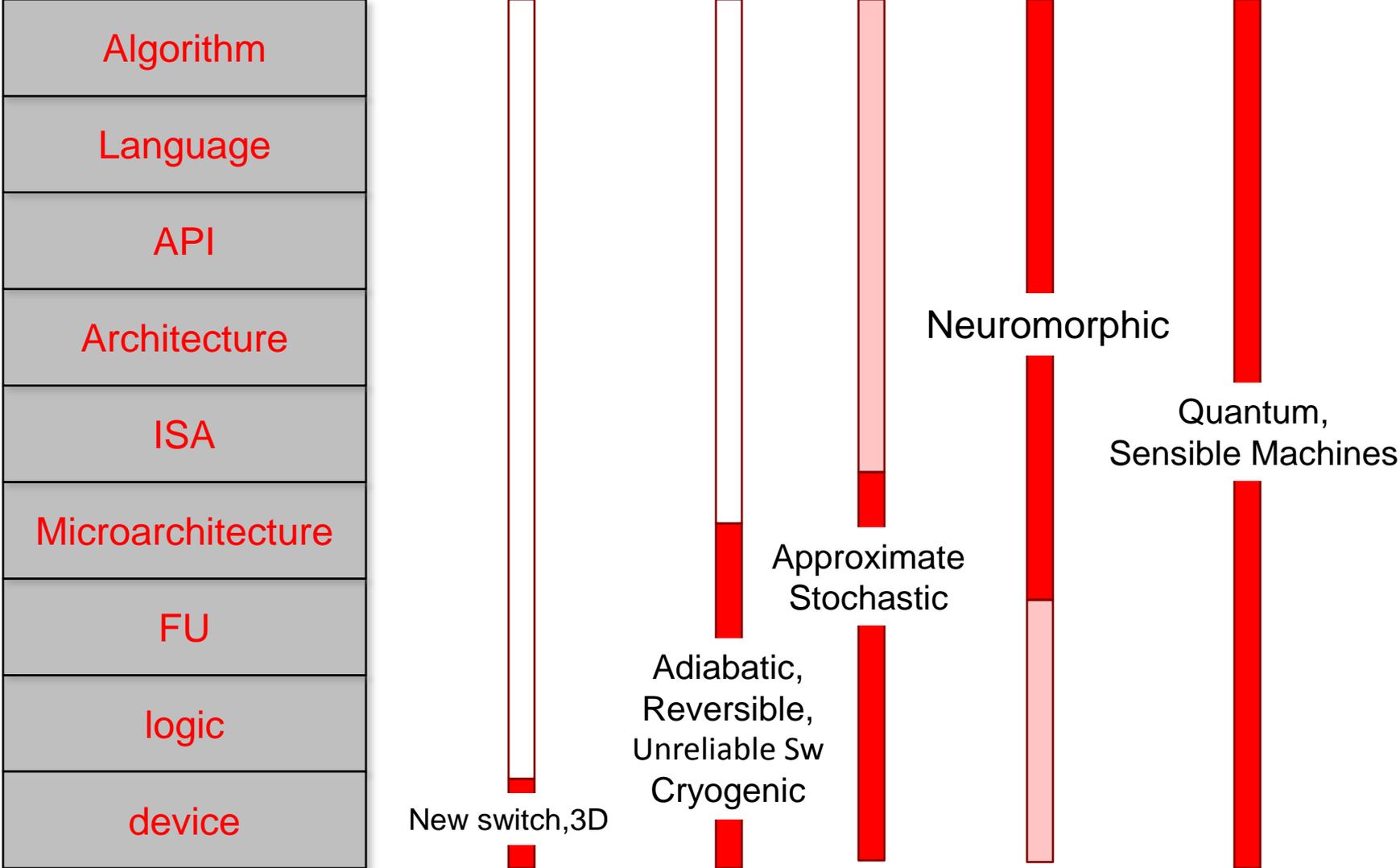
How we got here

- 1965: Software industry begins (IBM 360)
- 1975: Moore's Law
- 1985: "Killer micros": HPC, general-purpose hitch a ride on Moore's law
- 1995: Slowdown in CMOS logic: superscalar era *begins*
- 2005: The Power Wall: Single thread exponential scaling *ends* (Intel Prescott)
- 2011-2015: Realizing the problem: Rebooting Computing
- 2025 (ca.): Moore's Law *for 2D lithography* ends "for real"

Some potential ways forward

- Many alternatives
 - New switch
 - 3D Integration
 - Adiabatic/Reversible logic
 - Unreliable switch
 - Approximate, Stochastic
 - Cryogenic
 - Neuromorphic
 - Quantum
 - Sensible Machines
 - ...
- *not all are general-purpose drop ins*
 - *(nor do they need to be)*
- Some are quite disruptive in fact

Differing Levels of Disruption in Computing Stack



LEGEND: No Disruption  Total Disruption 

Future Computing

Problem definition



Dispatch

Challenges:
Selection,
Compilation

Challenges:
Computation-platform
independent problem
definition language
(“The new Java bytecode”)

**Challenges:
Architecture,
Implementation**

- Approximate
- Quantum
- Neuromorphic
- Sensible machines
- “Traditional”
- ...

Roadmapping is Essential For Success

Moore defined the law, *Roadmapping with buy-in from industry kept it going* because roadmapping:

- 1. Tracks progress*
- 2. Finds roadblocks*
- 3. Identifies and compares potential solutions*
- 4. Pre-competitive/standards-like*

How do you roadmap the “rebooted” computing space?

- Far more complex than semiconductor roadmapping
 - The y-axis is not as simple as feature size anymore
 - Dimensions: computing approach, application domain
- More complex, yes, but eminently do-able

Today's Goals

- We educate and inform you about what is going on (prepared agenda)
- We educate and inform each other (discussion groups)
- We educate and inform the wider computing community (post-summit report and additional activities)

Organization of the workshop

- Four main technology presentations + “Sensible Machine”
 - Our judgment of top areas with papers by leading researchers
 - Each based on peer reviewed papers published in IEEE Computer
 - We have a hardcopy for you
 - Three with two talks: (a) visionary picture (b) experimental results
 - Probabilistic methods
 - N3XT 10× to 1000× performance from new devices and 3D
 - Neuromorphic and “Sensible Machine”
 - Superconducting topic area with one talk
- Short presentations by leading sponsors
 - ITRS 2.0, SRC, IEEE (this talk) supporting industry
 - NSCI, IARPA, DARPA, and OSTP Grand Challenge
- Working groups (next slide)

Working groups

- Working group format
 - Three topic areas:
 - (a) random/approximate/probabilistic Mountain/Monroe
 - (b) Beyond CMOS Gargini
 - (c) neuromorphic DeBenedictis/Lu
 - Two periods, each with a meetings followed by outbrief panel
- Workshop report
 - Identify top research priorities in main areas
 - Develop group consensus of expectations on, say, 5 year intervals
 - ✓ Could become a roadmap for devices and systems
 - Compare and contrast ideas in main areas
- Special session Friday afternoon
 - IEEE/ITRS-2.0 “Sensible Machine” working group will meet after RCS 4 ends officially. Objective is to organize writing a whitepaper

Duration	Wednesday, December 9, 2015	
3:00	6:00 PM	Reception
	9:00 PM	End reception
	Thursday, December 10, 2015	
0:15	8:30 AM	Review of impetus for IEEE RC initiative, review of RC summits (3 pillars, complementary nature of various approaches, etc.). Tom Conte/Elie Track
1:15	8:45 AM	Track 1: Probabalistic/random/approximate big picture and experimental results L. Monroe; S. Khasanvis (tent.)
0:15	10:00 AM	Break
0:30	10:15 AM	Extra Track: Superconductive electronics/C ³ Marc Manheimer
0:15	10:45 AM	Review of other initiatives in this area – ITRS 2.0 Paolo Gargini
0:15	11:00 AM	Review of other initiatives in this area – SRC William Joyner
0:15	11:15 AM	Review of other initiatives in this area – NSCI William Koella
1:00	11:30 AM	Lunch (after a brief announcement of LPIRC 2016)
1:15	12:30 PM	Track 2: 3D integration and new devices big picture and experimental results Kirk Bresniker; H. S. P. Wong
0:30	1:45 PM	Track 1: Co-facilitators Dave Mountain, Laura Monroe
0:30	2:15 PM	Track 2: Beyond CMOS Benchmarking I. Young , plus discussion
0:30	2:45 PM	Track 3: Co-facilitators Erik DeBenedictis, Yung-Hsiang Lu
0:30	3:15 PM	Break
1:15	3:45 PM	Track 3: Neuromorphic/Sensible Machine big picture and experimental results Stan Williams; Dave Mountain
0:15	5:00 PM	Review of other initiatives in this area – OSTP Grand Challenge Lloyd Whitman
0:15	5:15 PM	Review of other initiatives in this area – DARPA Dan Hammerstrom
0:15	5:30 PM	Review of other initiatives in this area – IARPA Jason Matheny
0:30	5:45 PM	Break (needed for set up by hotel) and *** GROUP PICTURE ***
0:45	6:15 PM	Posters (in same room as reception)
2:00	7:00 PM	Reception starts in poster area
	9:00 PM	End reception
	Friday, December 11, 2015	
0:30	8:30 AM	First working group review
1:00	9:00 AM	Track 1: Co-facilitators: Dave Mountain, Laura Monroe
0:30	10:00 AM	Track 2: Moore's law E3S Eli Yablonovitch
0:30	10:30 AM	Track 3, continued Neuromophic tech. Matt Marinella
0:30	10:30 AM	Steep Slope Transistors S. Datta
0:30	10:30 AM	Dot Product Engine J. P. Strachan
1:00	11:00 AM	Second working group review
0:30	12:00 PM	Lunch
0:00	12:30 PM	RCS 4 Adjourns
5:30	12:30 PM	Associated IEEE/RC "Sensible Machine" Grand Challenge group meeting
	6:00 PM	Sensible Machine group meeting adjourns

And finally:

Leave your agendas at the door.