

Break-out session topic

- Articulate a grand-challenge/big-idea for the architecture community
 - Short description accessible to broader CS
 - What is the expected benefit if successful?
 - How will it push the field forward?
 - Which related disciplines will it draw from (PL, OS, ML, etc)? And how?

Group 1

Lead: Ras Bodik

*Christos Kozyrakis, Simha Sethumadhavan, Amrita Mazumdar,
Vincent Lee, Mark Hill, Kayvon Fatahalian, Mattan Erez, Lisa Wu,
to complete*

Democratize software-hardware development

Develop hardware fast and collaboratively, just like software. Build working systems with silicon at the bottom. From maker spaces to commercial dev.

Expected benefit: **Make Hardware Design Great Again**

Areas that this would revolutionize:

- 1) **IoT** (pervasive, distributed, low-power)
 - personal health monitoring
- 2) **ML** and science (big data)



Democratize software-hardware development

How will this happen? Who will help us?

- 1) Democratize manufacturing. Like DARPA MOSIS but \$1/chip. (**Kickstarter**)
- 2) Develop repository of modifiable libraries, from CPUs to accelerators (**github**)
- 3) Compilers to hardware (**CAD**)
- 4) Domain-specific design languages (**PL**)
- 5) Analyze hardware designs for privacy, and other properties (**FM**)



Group 2

Lead: Joel Emer

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Michael Ferdman

Hassan Muhammad

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Reduce cost to solution by N orders of magnitude

Defining problem

- Ease definition of problems that can be solved with computation
- Allow specification of accuracy/tolerance requirements
- Allow specification of time (maybe real-time) constraints

Expression of 'program'

- Ease of expression of algorithm (and learned components)
- Enable analyzable/predictable systems (taking constraints into account)
- Allow expression of approximate computing and security requirements

Hardware design

- Improve time to design, e.g., adding accelerators

Runtime metrics

- Reduce cost of computation (including cost-of-ownership) by factor of X
- Reduce computation time/energy
- Measurement/enforcement of constraints



[Grand challenge title]

Pass Turing Test (Societal, Application-driven)

Enable personalized medicine/realtime bio-medical introspection (Societal, Application-driven)

Reduce time to solution by N orders of magnitude (Advancing computing, enabling more applications)

Evaluating approximate computing (Advancing computing)

Breach the gap between efficiency and programmability (Advancing computing)

Self-organizing computing (Application-driven, advancing computing,)

Achieve N MIPS in human power constraints (Advancing computing)

Create a brain-inspired computer (Advancing computing, application-driven?)

Enable the Star Trek economy (societal, application-driven)

Eliminate crime (societal)

Create analyzable/predictable systems (advancing computing)

Reduce cost of computation (including cost-of-ownership) by factor of X

Create quantifiably tamper-proof systems

Create the next parallelism thing



Group 3

Lead: Sarita Adve

Matt Sinclair, Mike Taylor, Moyang Wang, Steve Keckler, Aasheesh Kolli, Lide Duan, Dayeol Lee, Boris Grot, Sebastien Raase

Democratizing Specialization

- Future systems need to be vertically integrated, specialized
- Provide infrastructure/foundation to enable small teams to innovate, design such systems
- Redesign the stack around specialization
- How to design hardware, express interfaces for other layers?
- Systems approach - communication, computation, concurrency, distributed systems



Expected Benefit if Successful

Death of Moore's Law? Whatever!

Cambrian explosion of innovative systems

True co-design: Software, applications community leverage hardware and vice versa seamlessly



Which Disciplines

ALL



Group 4

Lead: Babak Falsafi

*Alvin Lebeck, Tom Conte, Sungpack Hong, Djordje Jevdjic,
Alex Daglis, Josep Torrellas, Lunkai Zhang, Philip Wong,
Michael Mishkin, Javier Picorel, Sandhya Dwarkadas*

Healthcare On-the-Go (or beyond personalized medicine)

What?

- 24-hour monitoring, diagnosis, prevention and treatment of disease for individuals

What will it buy us?

- Improve human condition
- Avoid 3-hour lines at ER!



How will it advance the field?

- Use of novel devices
- Interdisciplinary research/new domain
- Human-center design
- Interfaces
- Biocompatibility
- Ultra low-power
- Real-time computing
- Rethinking of levels of abstraction



What other communities to interface with?

- Device technology and circuits
- Biomedical engineering (sensors and actuators)
- HCI
- Computational biology
- System software (databases, OS, PL)
- Security & privacy
- Distributed systems
- Real-time computing
- Computer Vision/Machine Learning
- Theory & algorithms



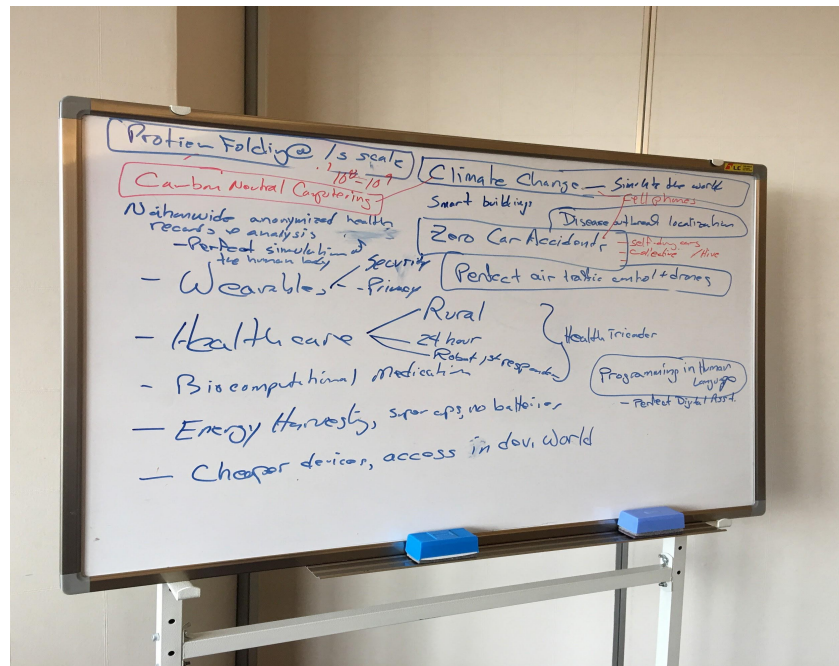
Group 5

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Carbon Negative Computing



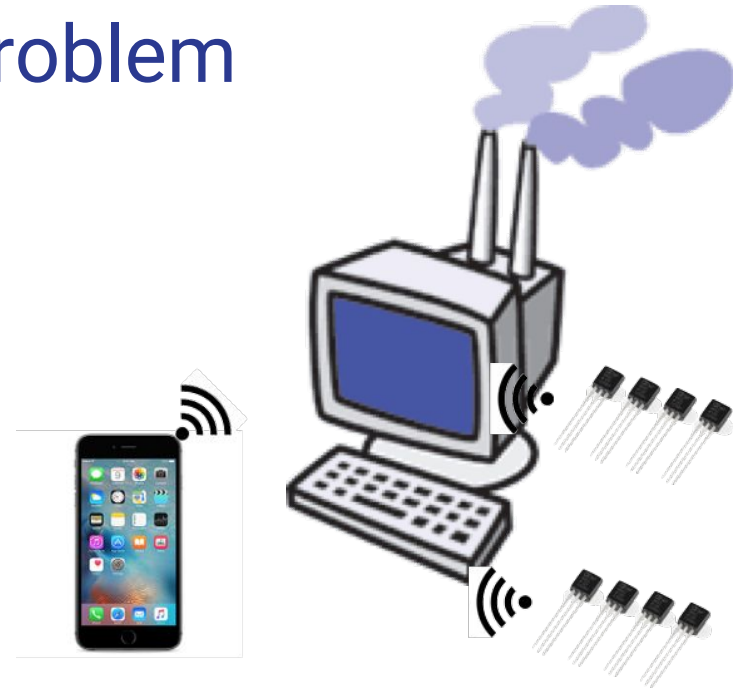
Carbon Negative Computing: Problem

Problem Definition:

- * Climate change is a fundamental problem
- * Computing is making it worse at a fast pace

Computing should be part of the solution,
not the problem.

- * Computing should save more carbon than it consumes



Carbon Negative Computing: Solution

Direct Impact: Energy-efficient computing

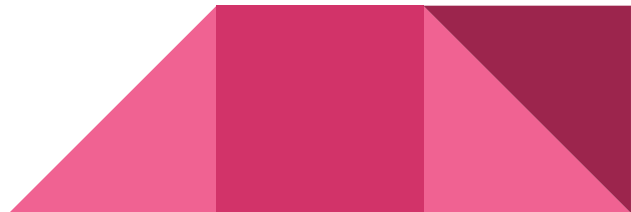
- * dynamic specialization
- * approximation

Indirect Impact: Using computing to reduce carbon

- * telecommute vs. physical commute
- * collective collaboration reduce congestion, zero car accidents

Reduce embedded energy:

- * reduce/eliminate rare earth materials
- * use carbon nanotubes and biologicals



Carbon Negative Computing: the rest

Benefits:

- * Carbon reduction \Rightarrow reduce climate change, etc.

How will it drive the field?

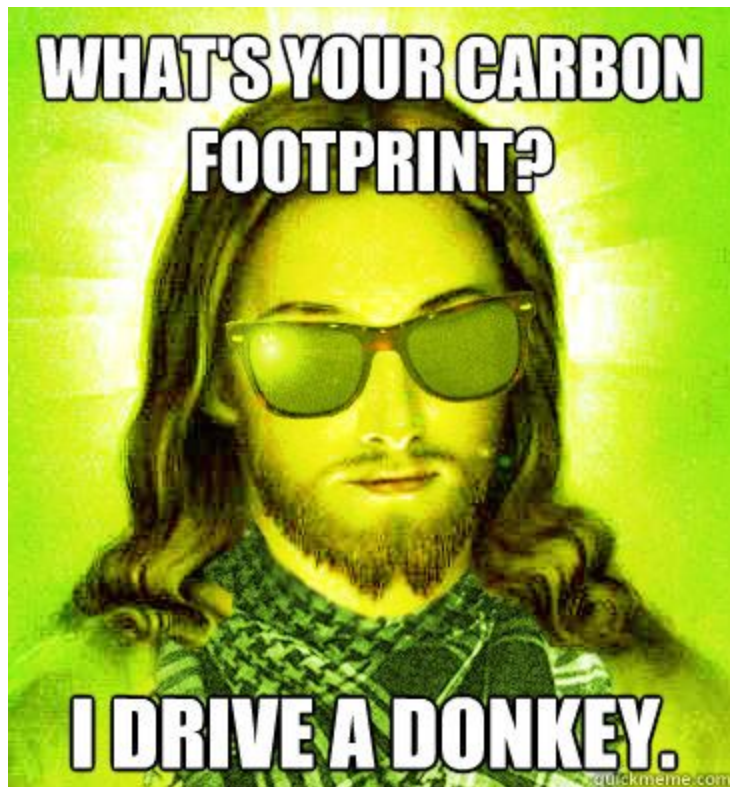
- * Problem-driven solutions move more quickly
- * New interfaces, rapid prototypes

Disciplines:

- * Crossing layers impacts all disciplines



**WHAT'S YOUR CARBON
FOOTPRINT?**



I DRIVE A DONKEY.