



MicroIntegrated Wireless Sensors and Networks for Demand Response and Energy Efficiency



Multi-disciplinary Collaboration Team:

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- ◆ David Auslander: ME Dept. (Phase One and Two)
- ◆ Ed Arens (&Charlie Huizenga): Center for Built Environment
- ◆ James Evans: Materials Science and Engineering
- ◆ Kris Pister (and David Culler in Phase One): EECS Dept.
- ◆ Jan Rabaey: BWRC, GSRC, EECS Dept
- ◆ Seth Sanders: EECS Dept
- ◆ Dick White: Berkeley Sensor & Actuator Center, EECS Dept.
- ◆ Paul Wright: BWRC, CITRIS , ME Dept.



Main “take-aways”



★ A new class of computing in last ten years:

- ◆ **Communication** with micro, low-power radios
- ◆ **Computation** with “Tiny OS”
- ◆ **Sensing** (including low cost MEMS sensing)
- ◆ All 3 combined in one very small “foot-print”

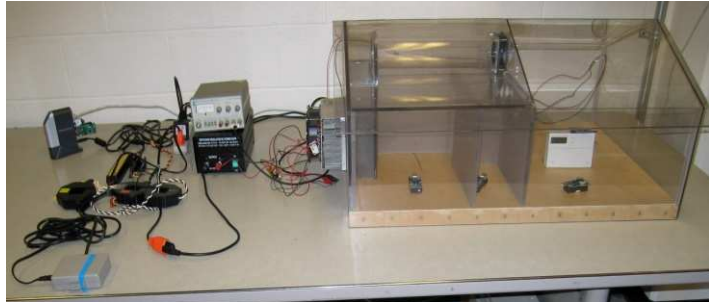
★ **Costs will soon be \$1.00 - \$5.00 per platform**

★ **Impact from DR-ETD**

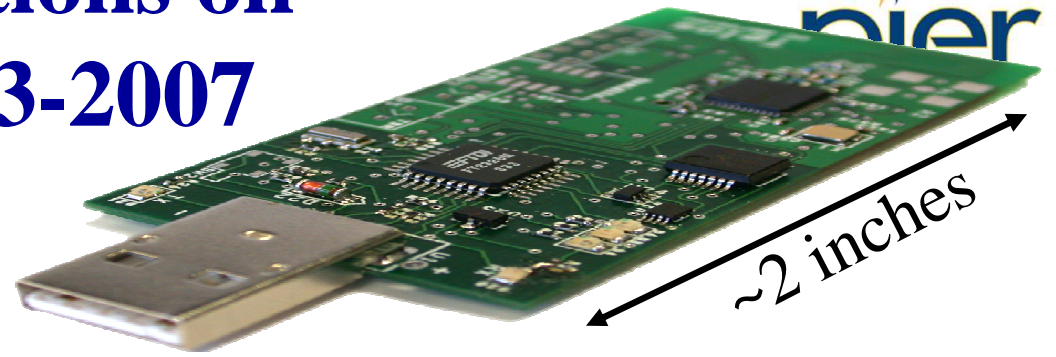
- Demand Response and Energy Efficiency eliminate the need for 5 power plants which, in turn, saves 9 million tons of CO₂ emissions or a \$10 billion in net savings to consumers.

– <http://www.epa.gov/cleanrgy/pdf/keystone/PrusnekPresentation.pdf>

Background: Applications on “motes” made in 2003-2007



2003



2004/5



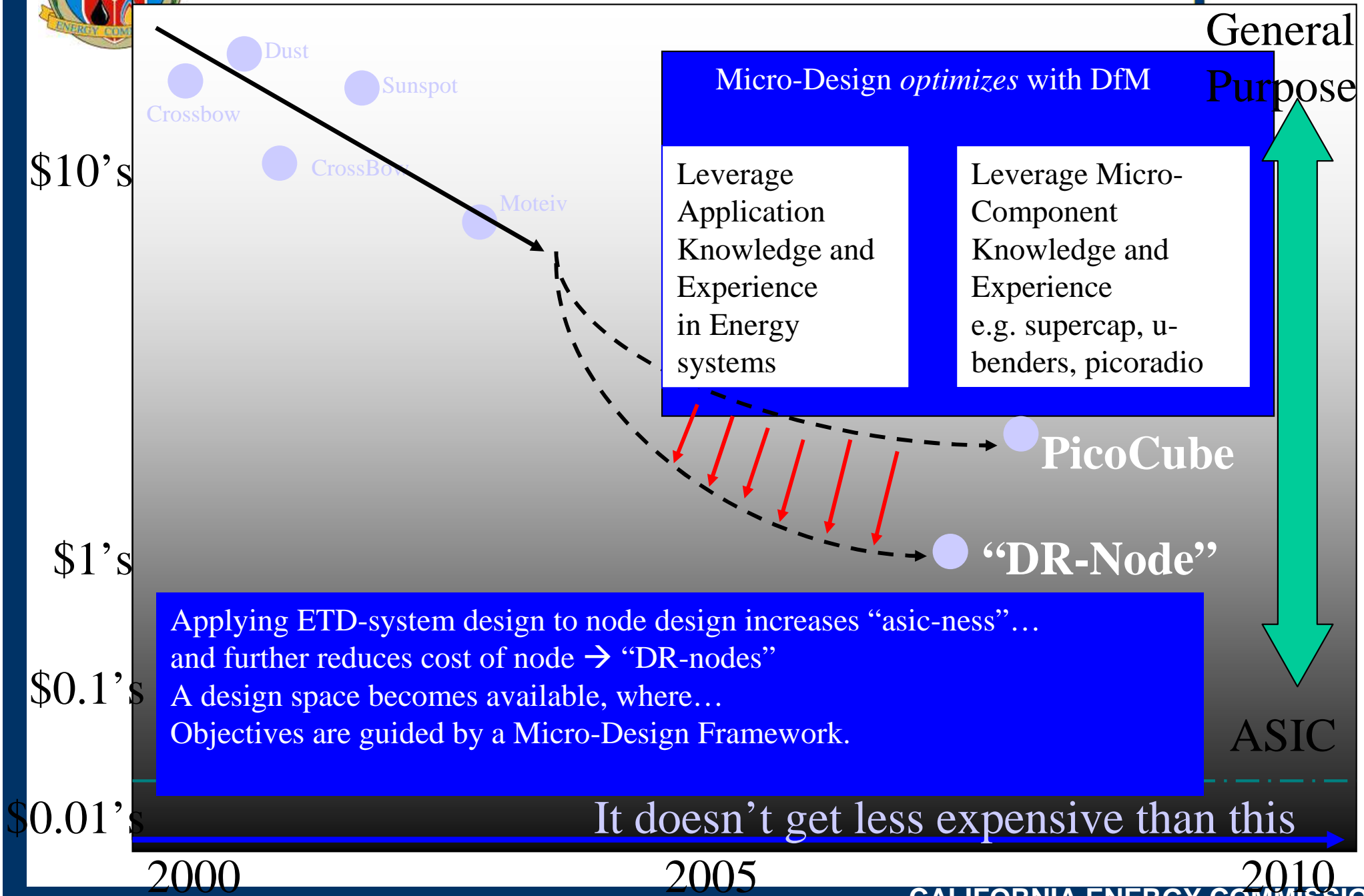
2006



2006 field deployments of REM multi-agent system with sense and actuation utilizing multi-hop wsn.



Micro Design and Manufacturing





Towards 10x10



Applications

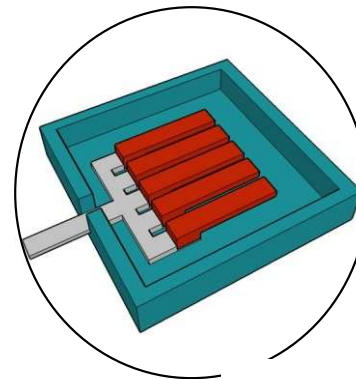
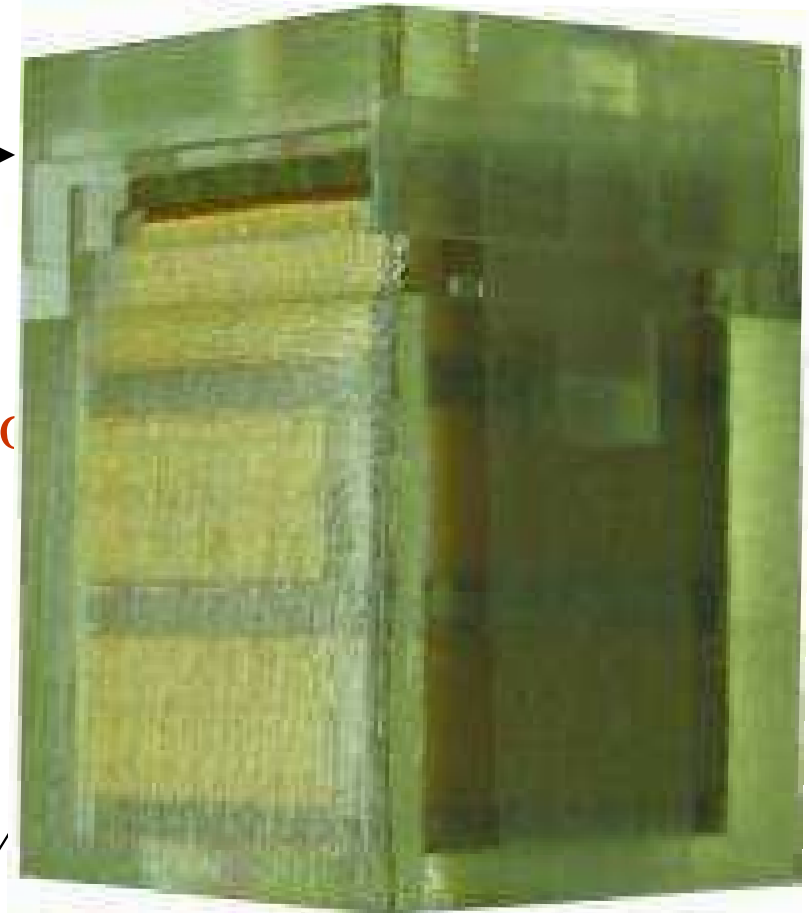
Control logic

Learning algorithms

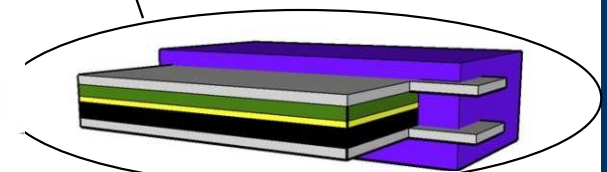
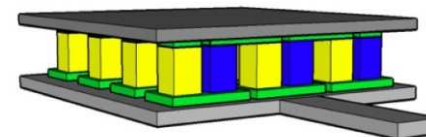
Automation

Distributed
throughout all
computers in the
system

Micro-sensors
Micro-radio
Micro processor



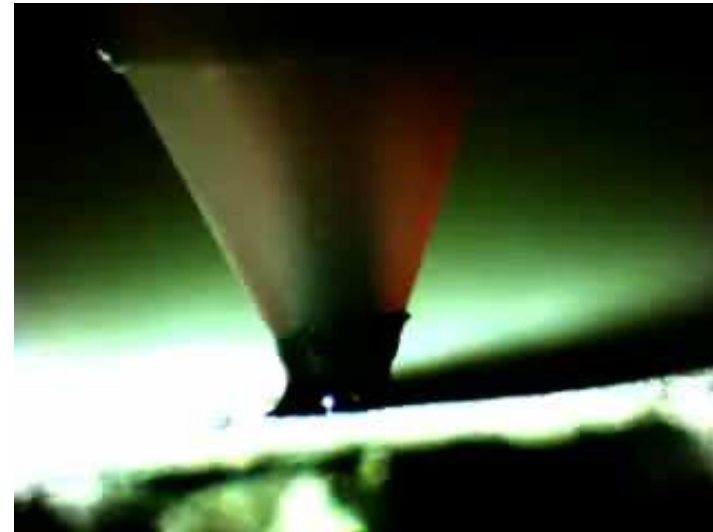
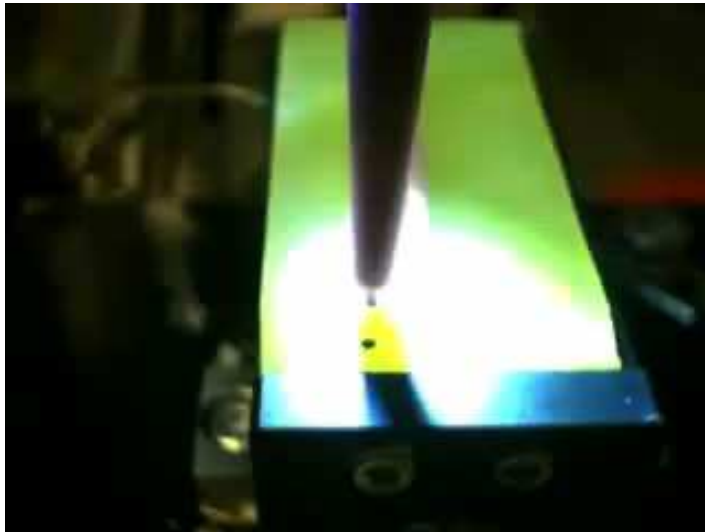
Micro-power
Supplies



Power Bus

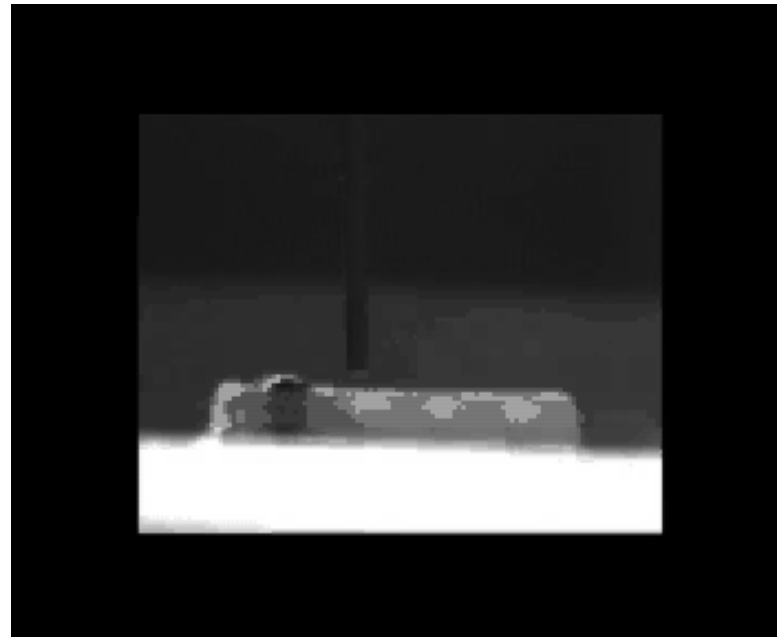


Printing custom electronics; with scalability to volume production





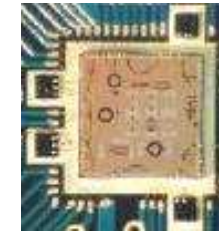
Scalable power harvesting



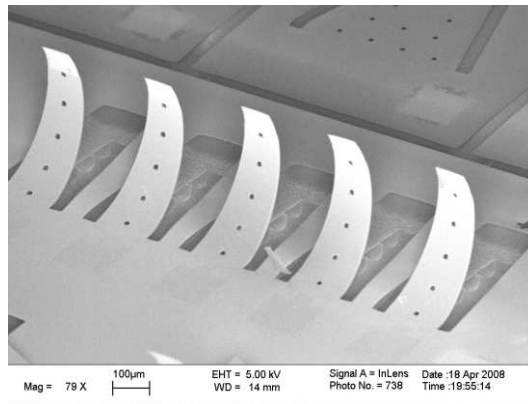


Micro Integration

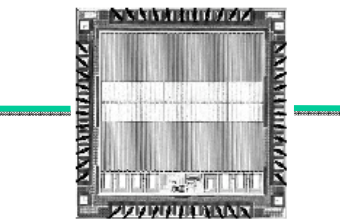
Integration using microfabricated, MEMS, and printed components



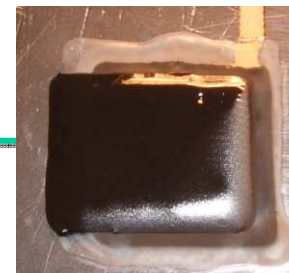
Low power radio (*Jan Rabaey*)



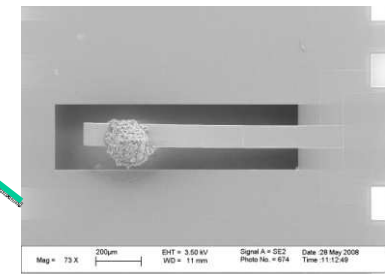
Microfabricated piezoelectric energy scavenging system (*L. Miller et al*)



Power condition circuitry (*S. Sanders*)



Dispenser printed capacitor (*C.Ho*)



Microfabricated current sensor (*Dick White/ E. Leland*)