

Systems Design for Autonomous Wireless Devices

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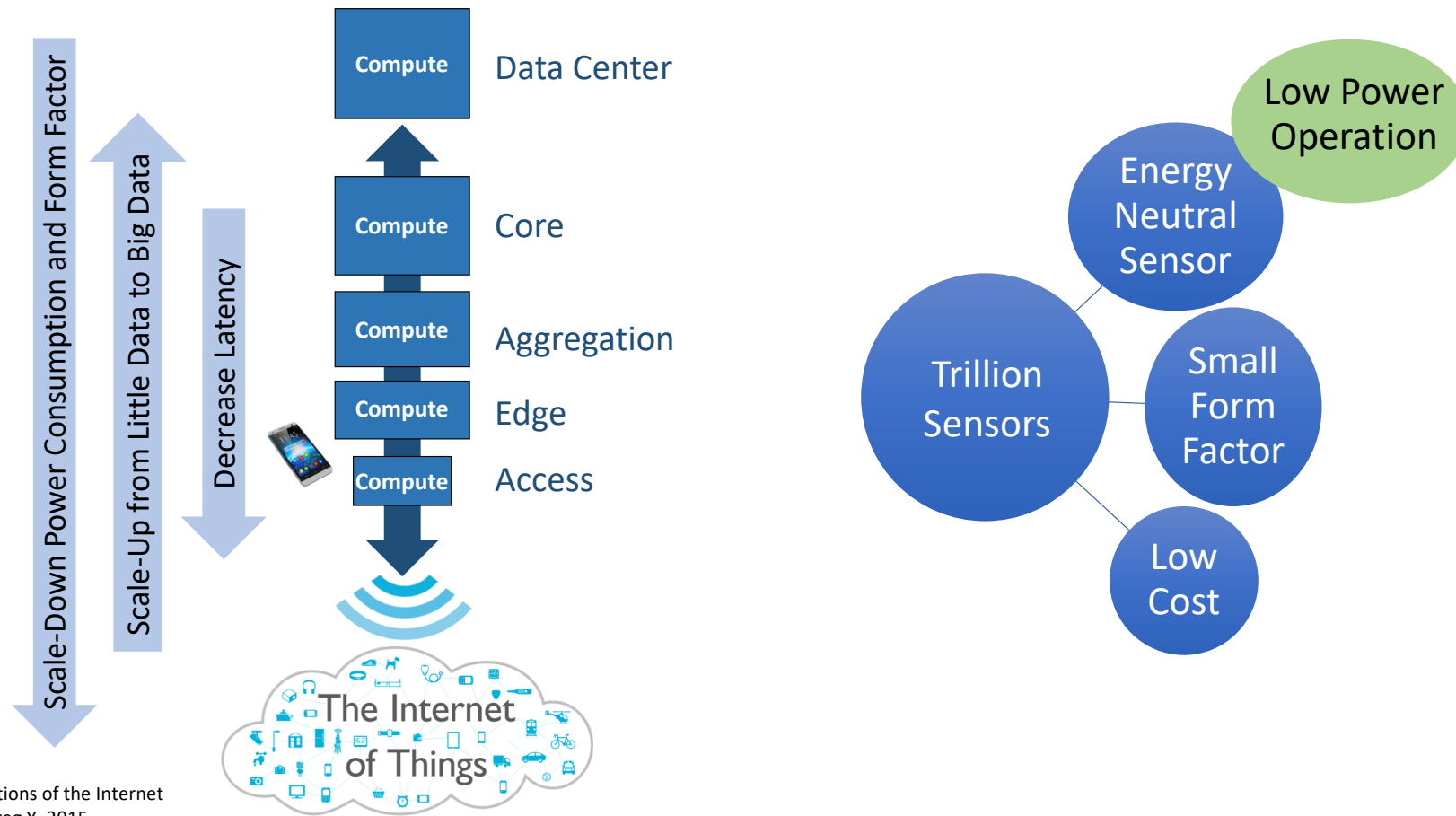
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Outline

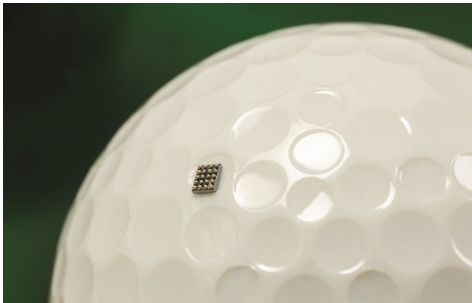
- Context
- What can help the sensor system's (IoT) designer?
- Solutions Explored
- Conclusions

Sensors and Compute in IoT



*VLSI implications of the Internet of Things – Greg Y, 2015

How small is small?



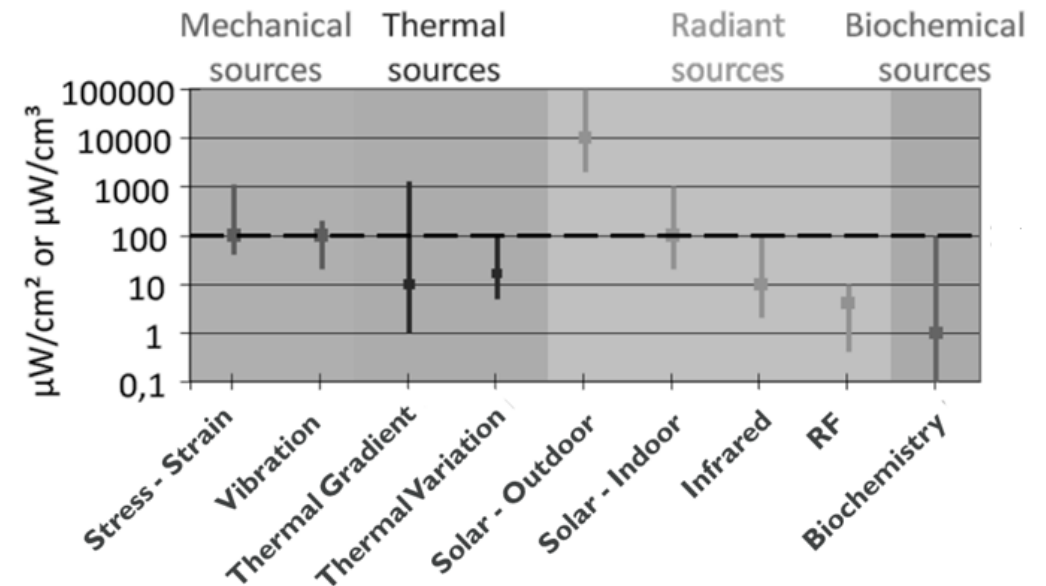
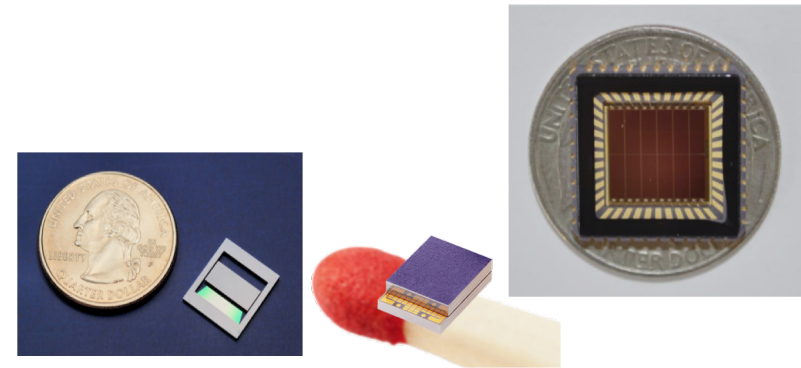
Freescale KL03

- Cortex-M0+
- 32KB Flash
- 2KB RAM
- 8KB ROM
- 12-bit ADC
- High speed comparator



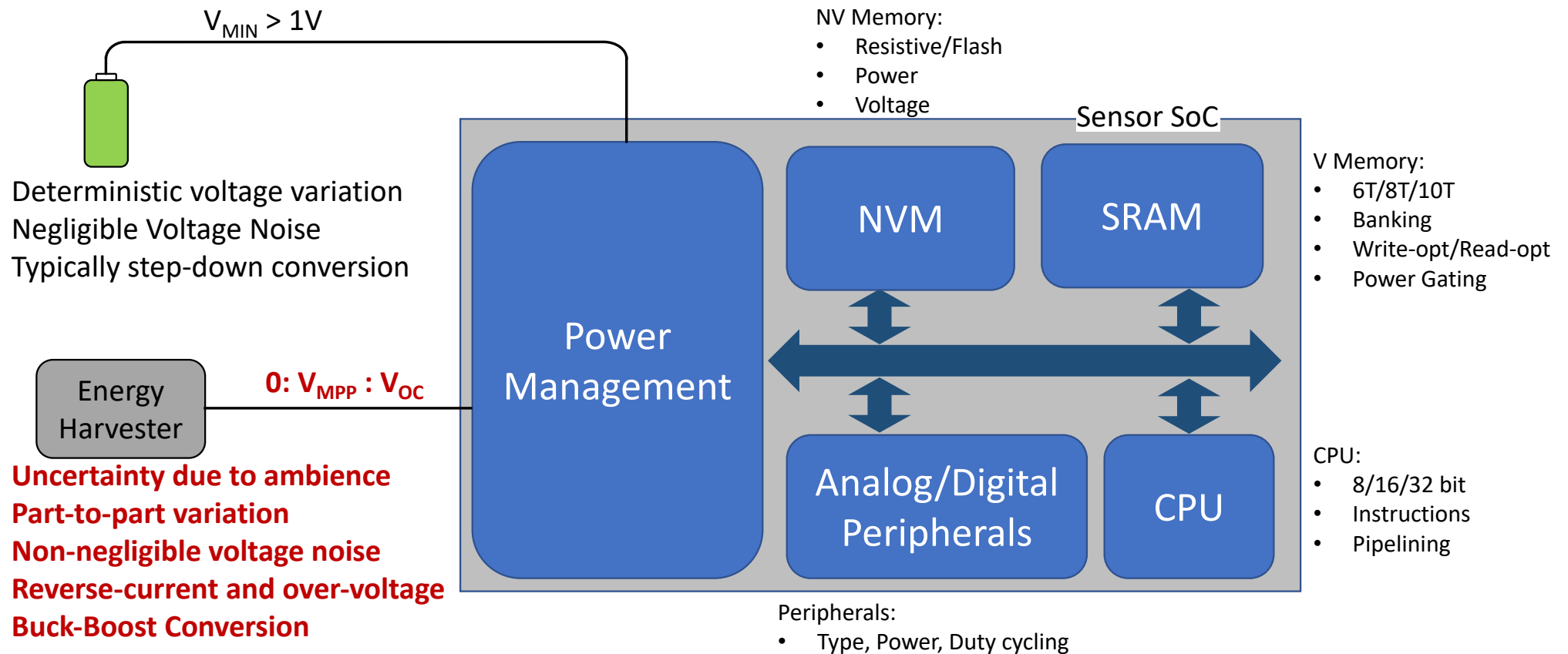
University of Michigan

- Cortex-M
- Custom memory
- Custom Radio
- Custom Battery
- Energy Harvesting

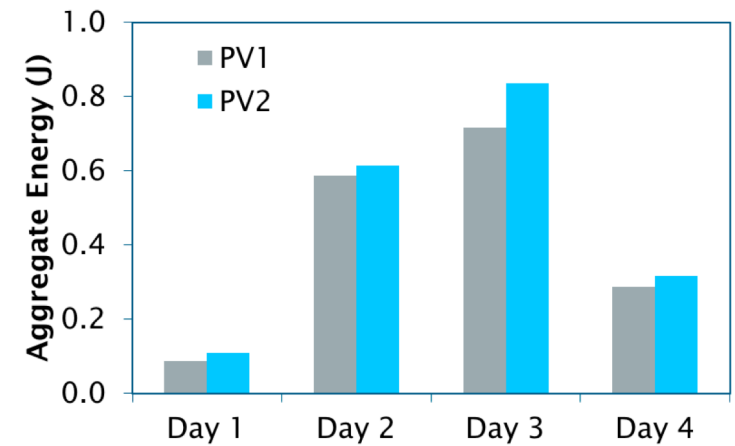
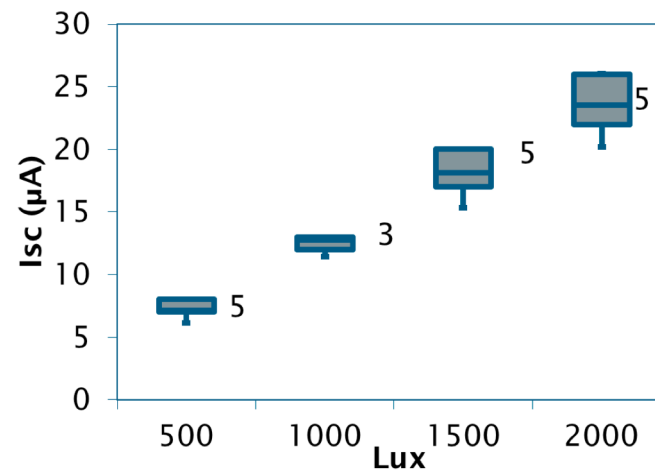
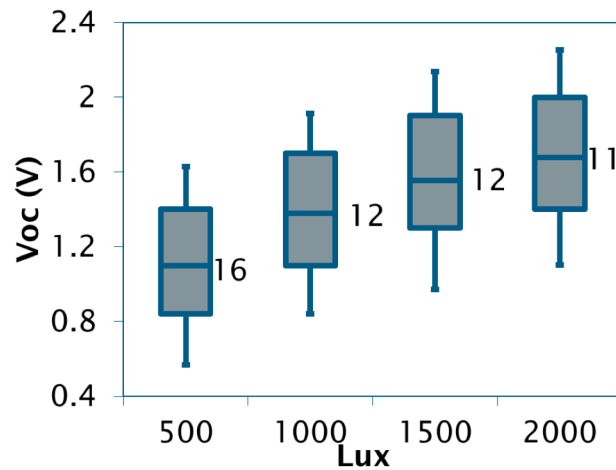


Boisseau, S., G. Despesse, and B. Ahmed Seddik. "Electrostatic conversion for vibration energy harvesting." *arXiv preprint arXiv:1210.5191* (2012)

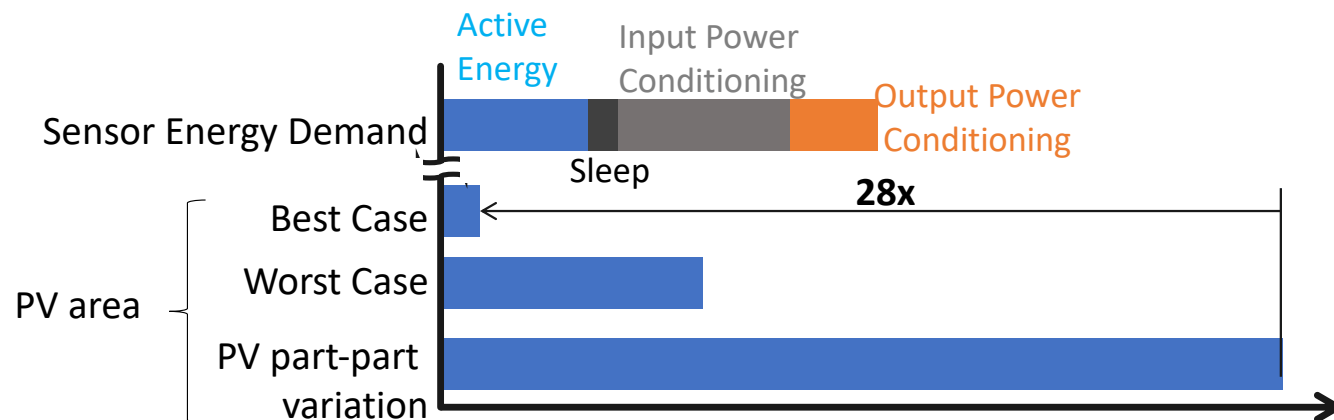
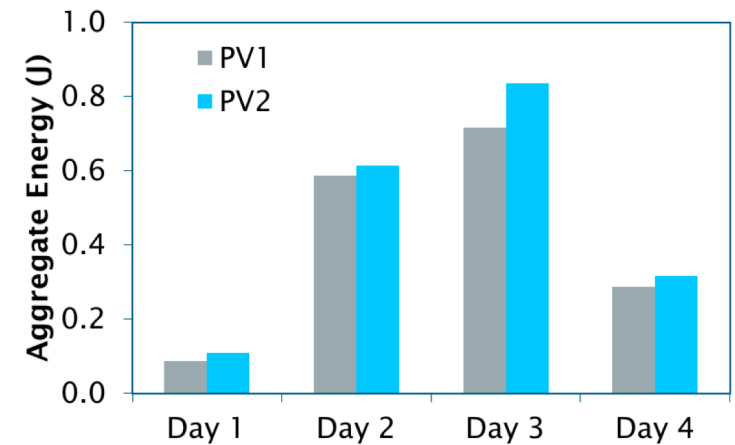
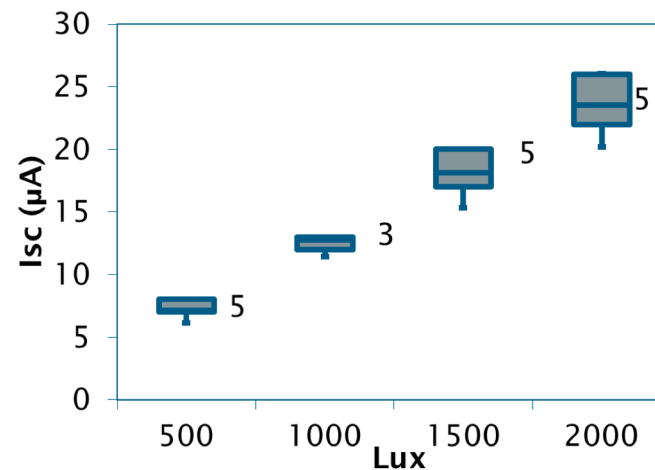
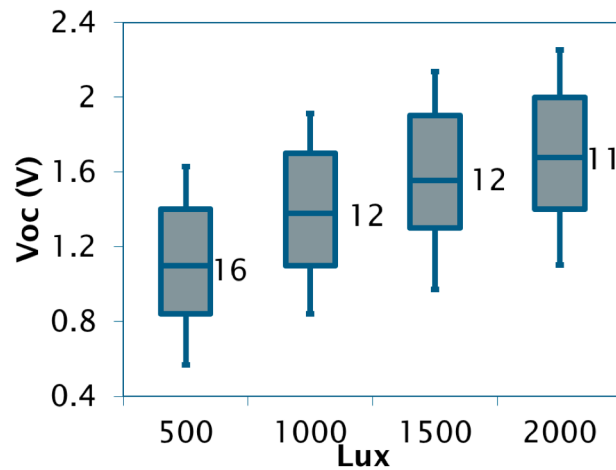
Trillion Sensor Nodes: Designer's Perspective



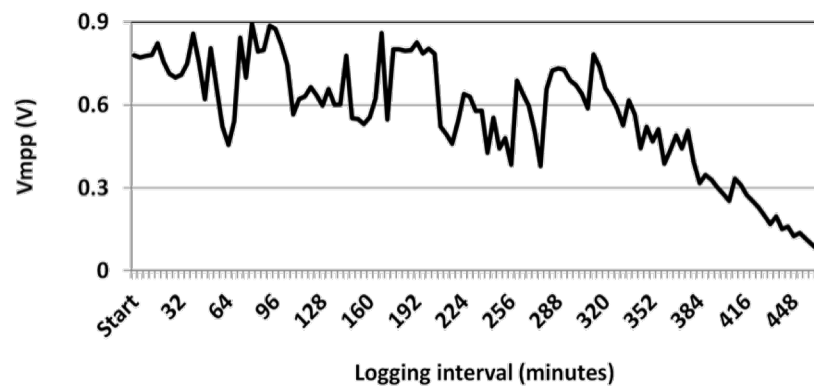
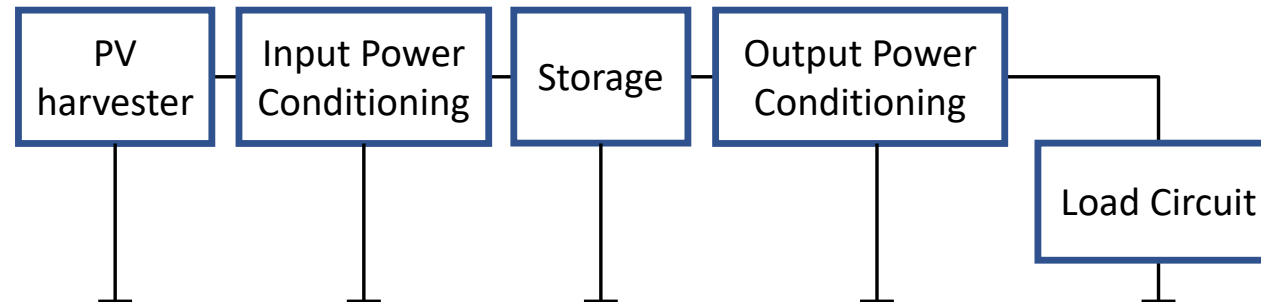
Modeling and Variability



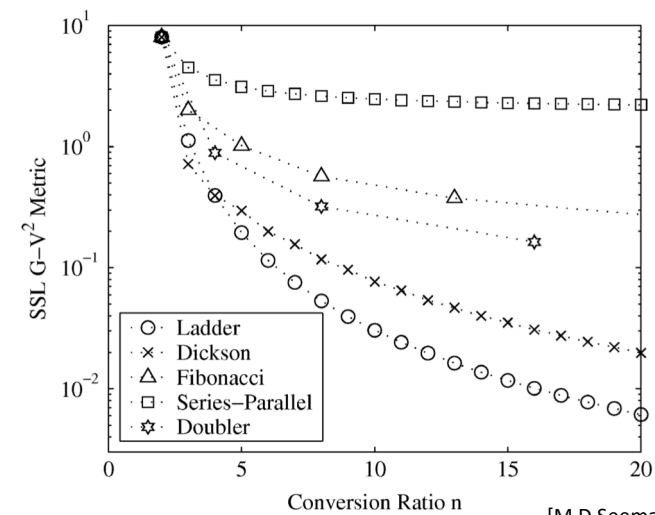
Modeling and Variability



Voltage, Power and Energy

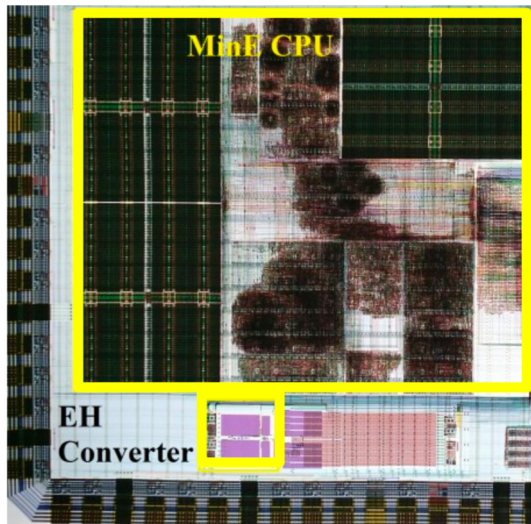
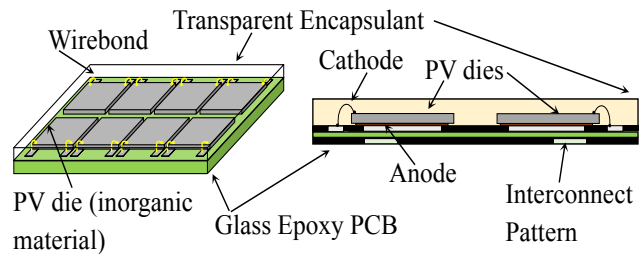


[Savanth TCAS'17]

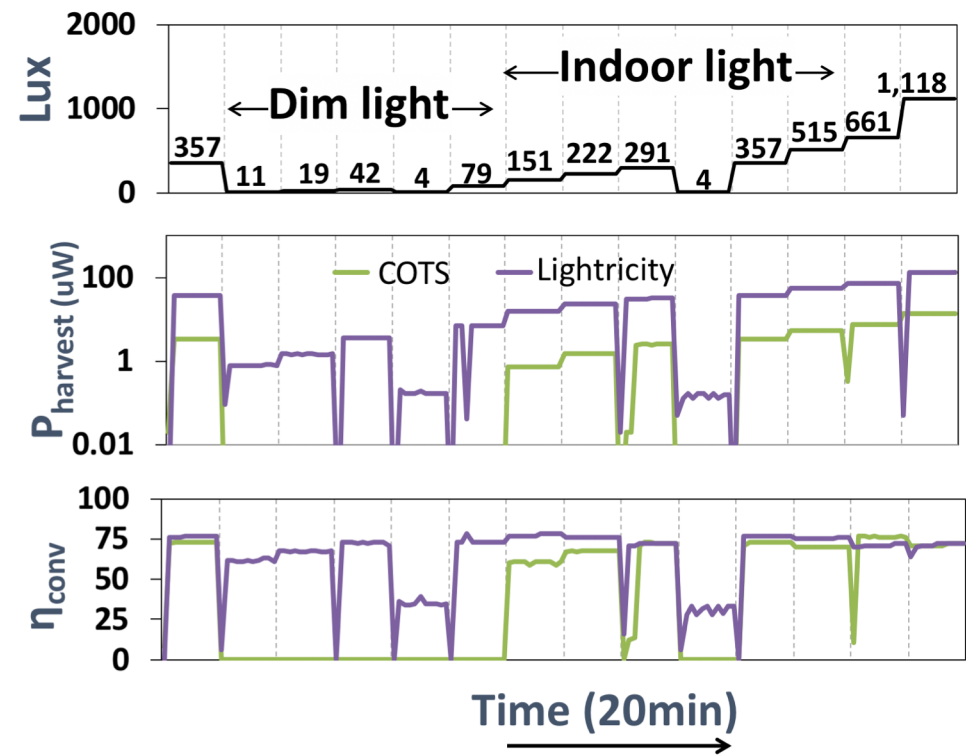


[M D Seeman, PhD Thesis, UC Berkeley]

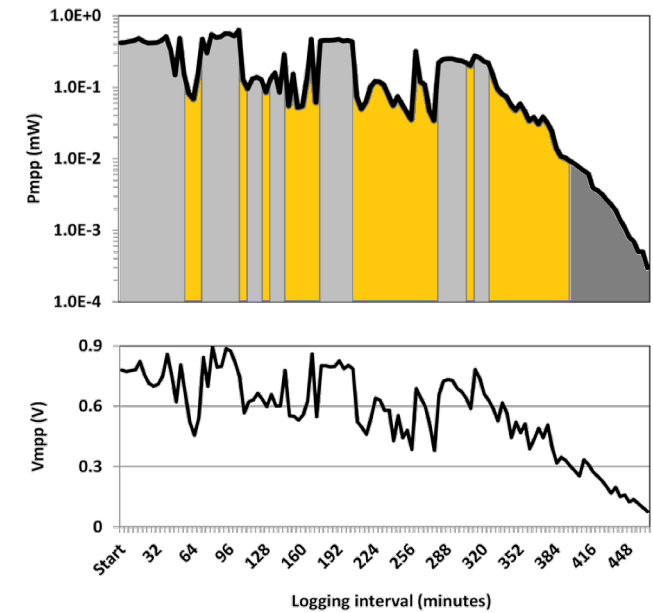
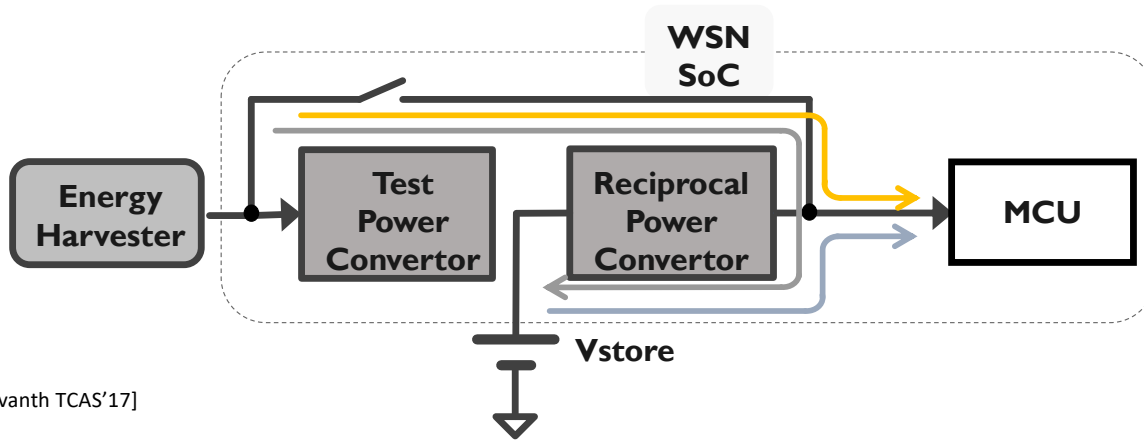
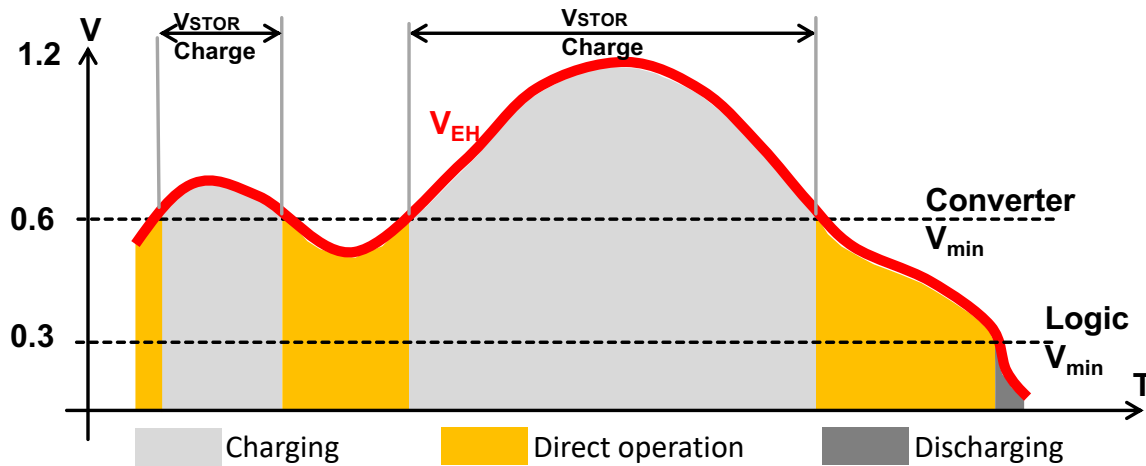
Solution: Co-design



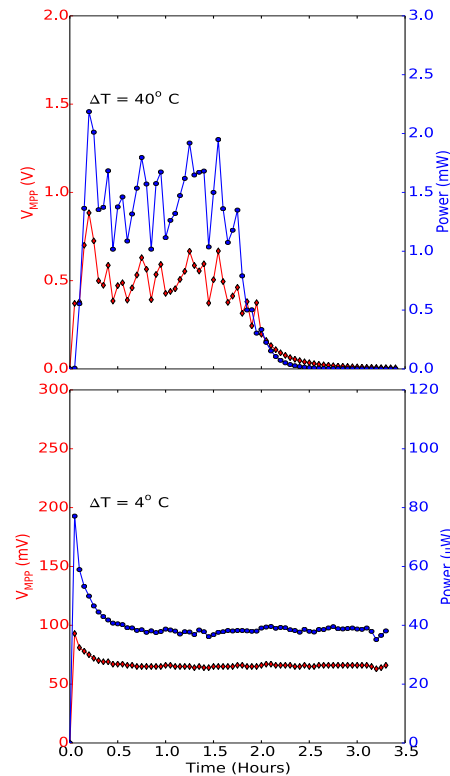
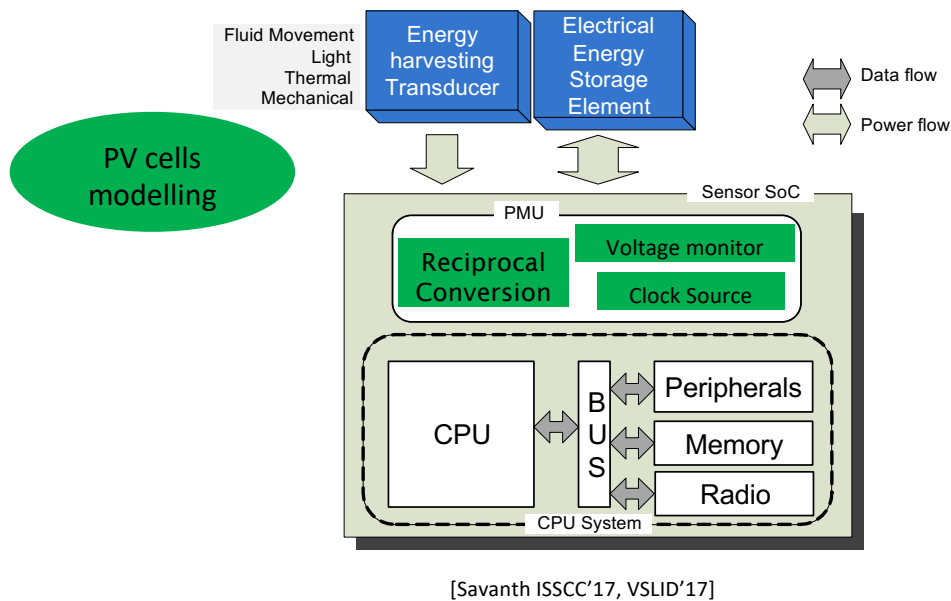
Block	Area (μm)
CHIP	1940 x 1940
LOGIC	1180 x 980
DCDC	175 X 210 (3%)



Solution: Selective Direct Operation



Solution: Holistic System Approach



Energy-neutral system operation with 50 lux continuous light or 200lux for 2hrs/day , 20°C ΔT continuous or 50°C ΔT for <1min/day

Conclusion

- Energy Harvesting and sensor system design for IoT
- Challenges with small scale energy harvesters
- Need for co-design and holistic system solution

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