

Low power/no power: moving to a world without batteries

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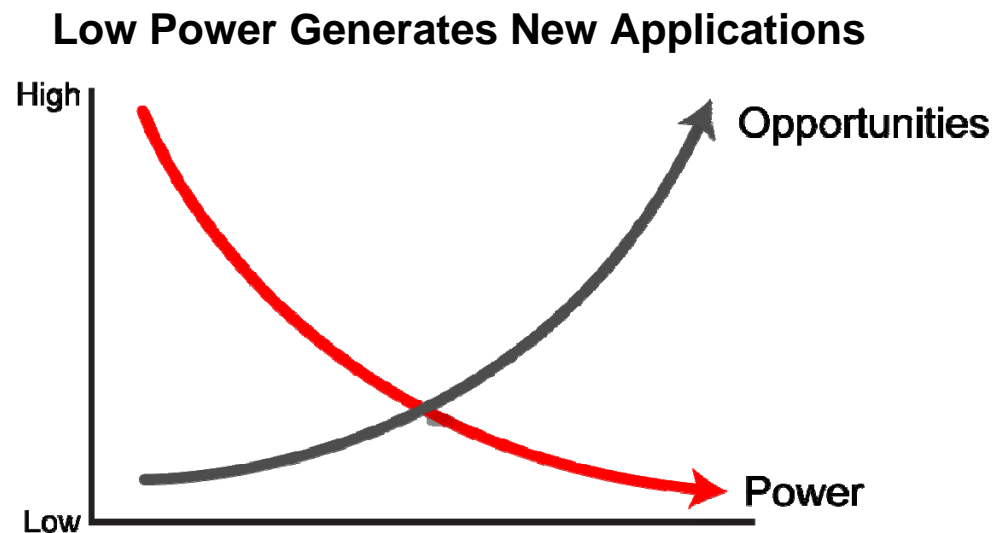
Vice president and director, DSP Solutions R&D Center

Dave Freeman

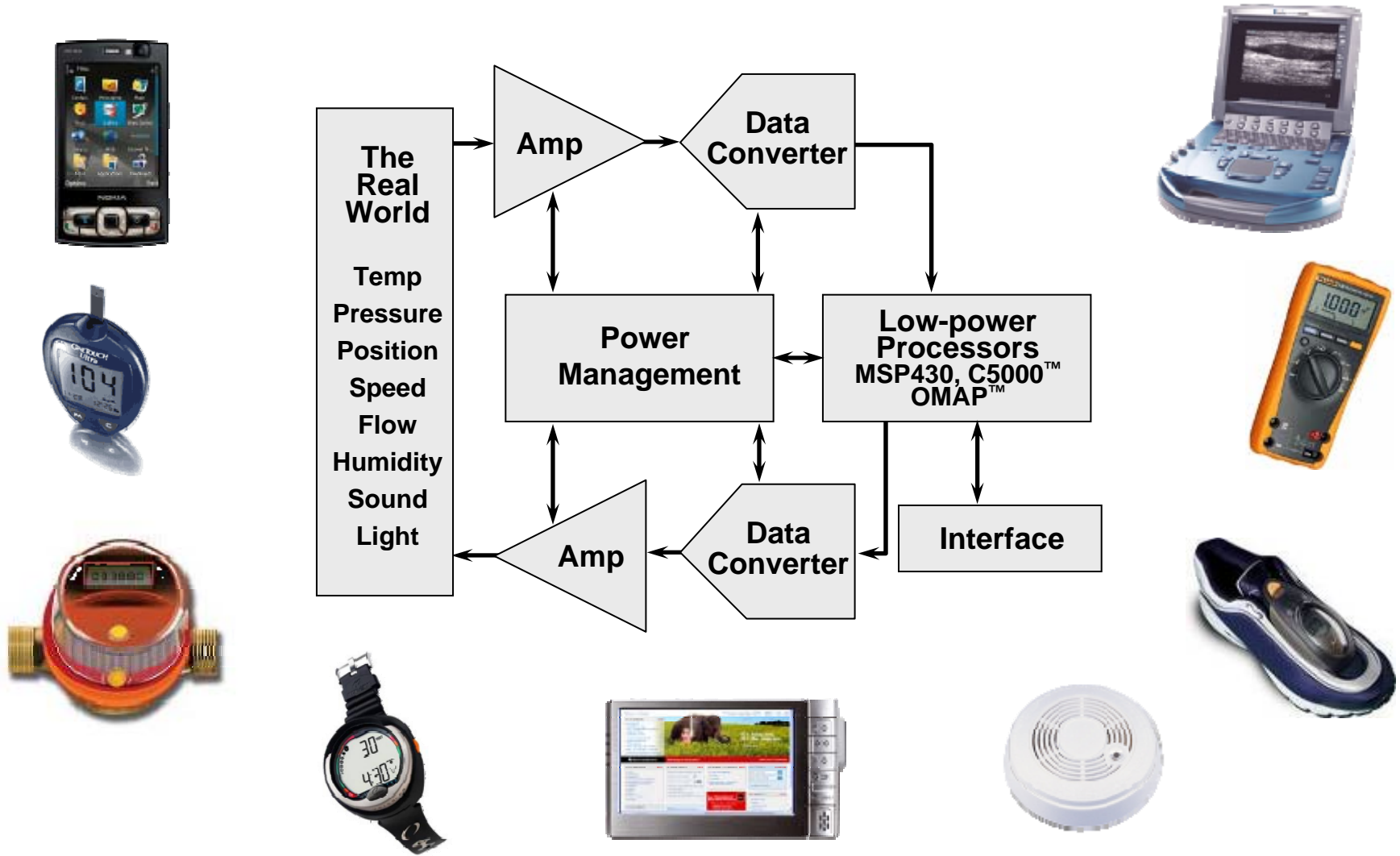
TI Fellow, Analog & Digital Power Control Products

Low power is TI core competency

- Drives more than half of TI SC revenue today
- Even more important in years ahead
- Emerging low-power applications provide explosive growth opportunities
- A low-power world without batteries is on the horizon

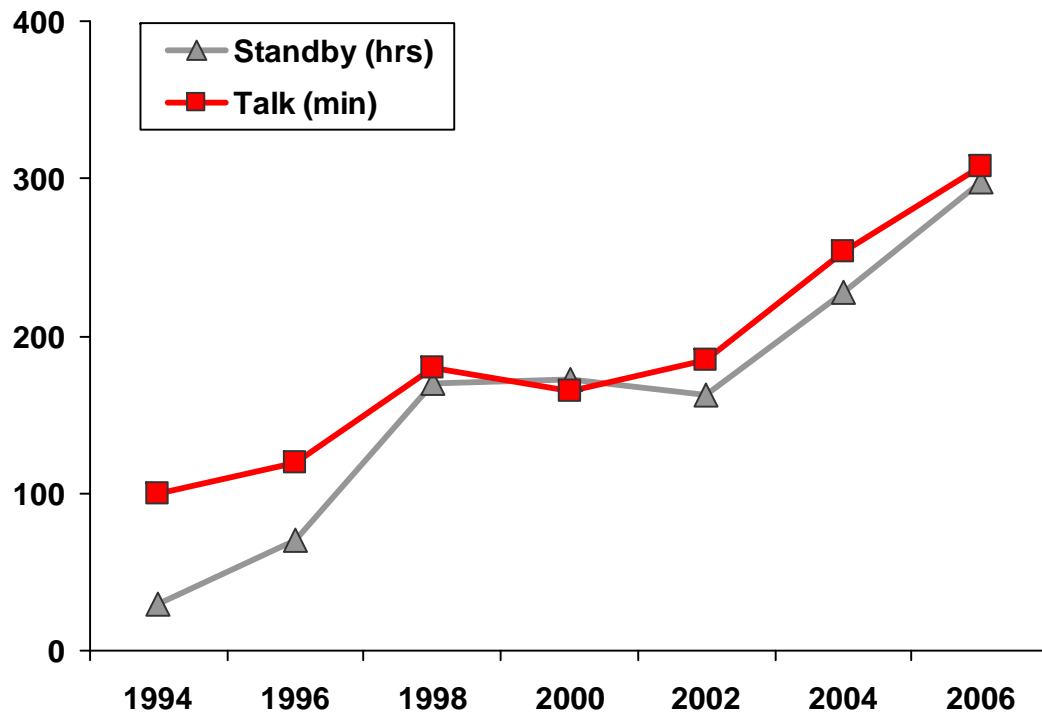


Systems approach required to optimize low-power applications



Handset trends: smaller, more functionality, longer battery life

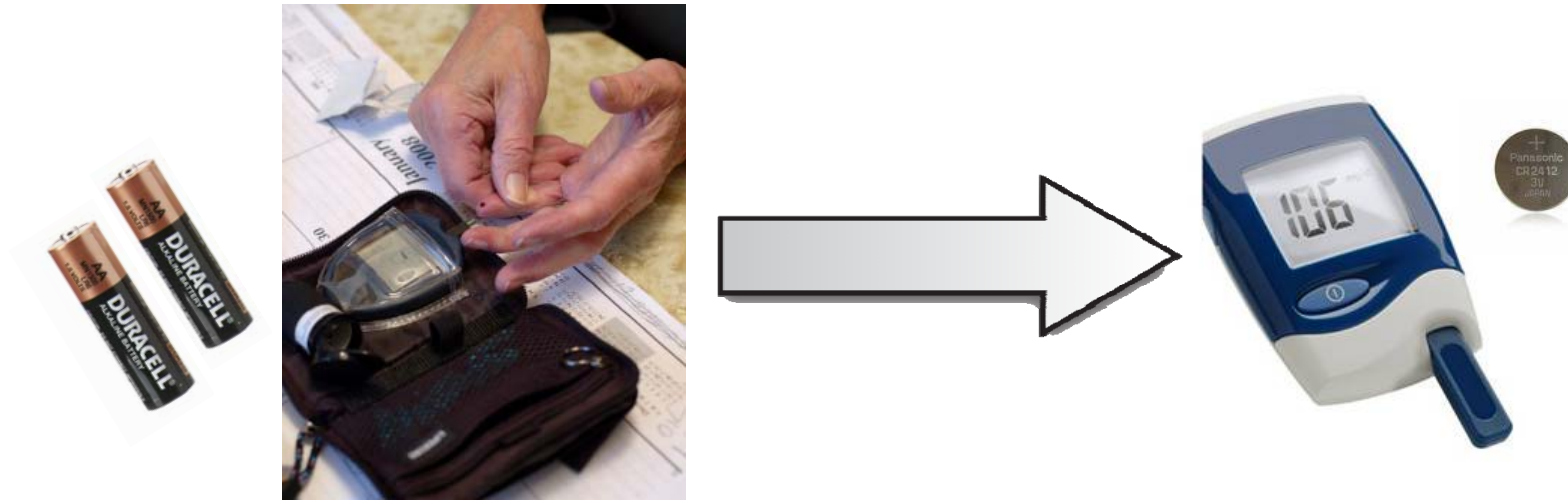
Average Battery Life



- Low-power/high-performance optimization
- Process technology, architecture and software
- Active and static power reduction
- Battery capacity improvements cannot do it alone

Driving down complexity and power in consumer medical devices

Glucose Monitor Example

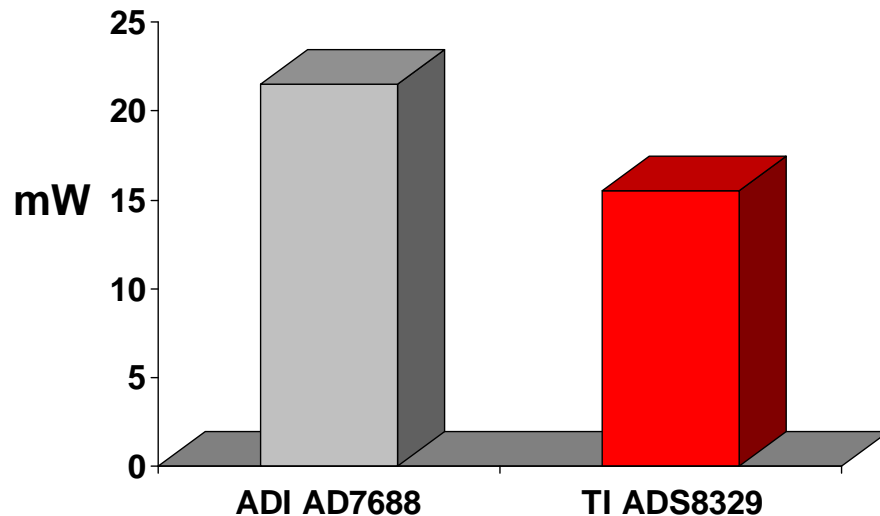


- ~3 months with two AA replaceable batteries
- 200 test strips per battery replacement
- 8+ chips: processor, memory, A/D converter, real time clock, op amps, etc.

- Lifetime sealed unit with coin cell battery (3 years)
- 2400 test strips
- 1 chip: MSP430 microcontroller SOC

Driving low-power leadership in analog

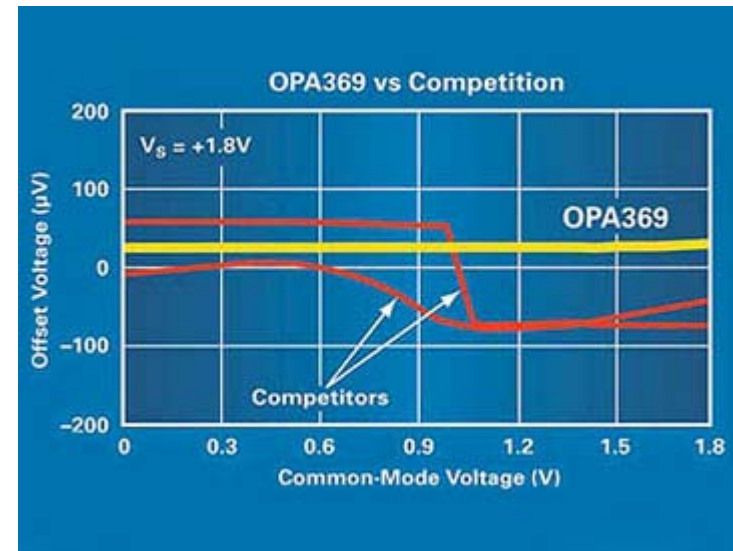
Industry's Lowest Power
16-Bit, 1MSPS A/D Converter



Applications

- Portable monitors: gas, light, safety
- Portable medical
- Portable instrumentation

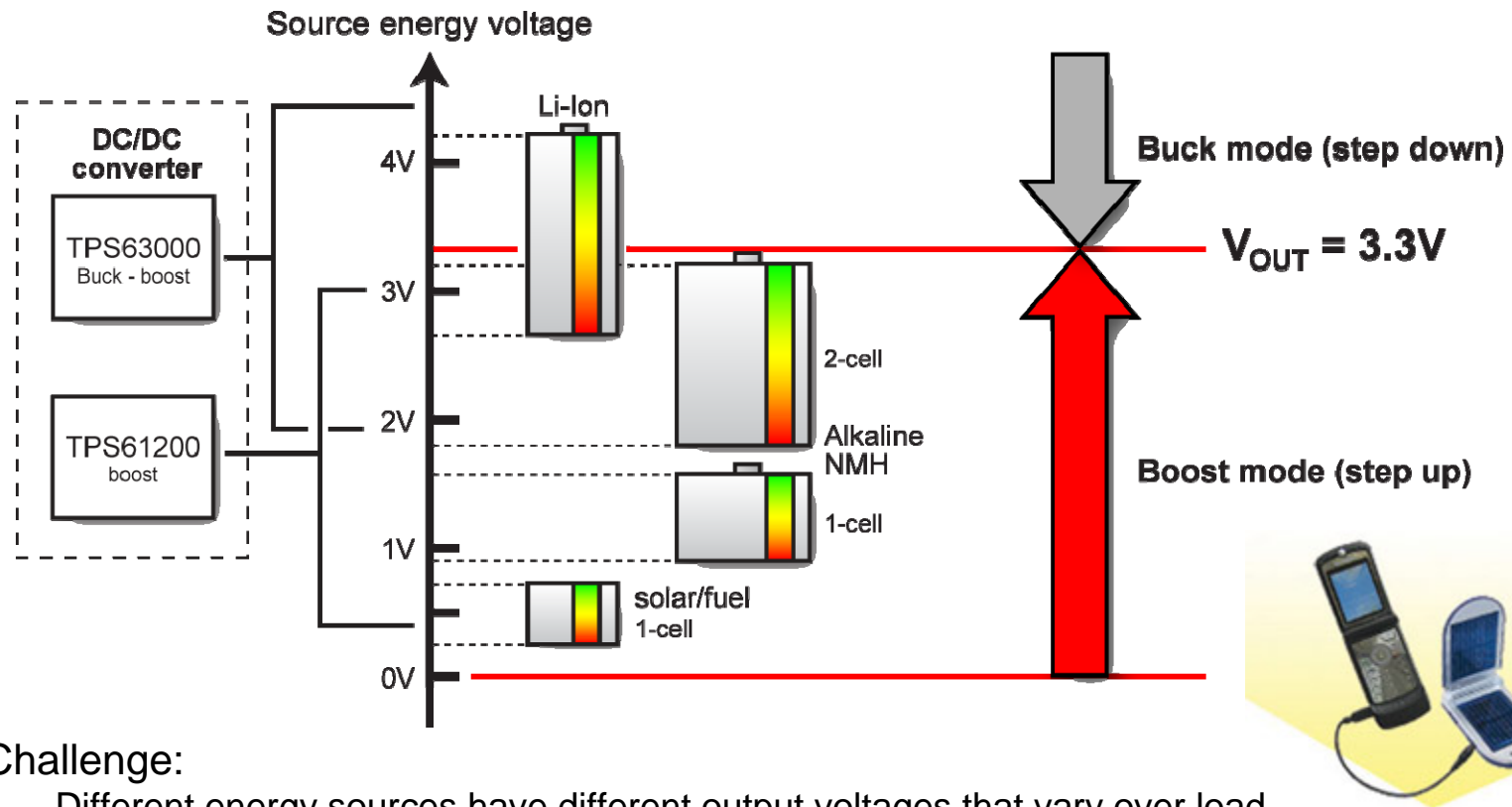
Industry's Lowest Power (1 μ A)
Zero Crossover Op Amp



Applications

- Portable instrumentation
- Portable medical
- Portable consumer

Analog power management solutions for a wide range of portable energy sources



- Challenge:
 - Different energy sources have different output voltages that vary over load, state of charge, temperature
 - But ... semiconductors require constant operating voltage
- Solution: Useful battery life extended by bucking (reducing) and/or boosting (increasing) battery output voltage
- Differentiation: conversion efficiency, size

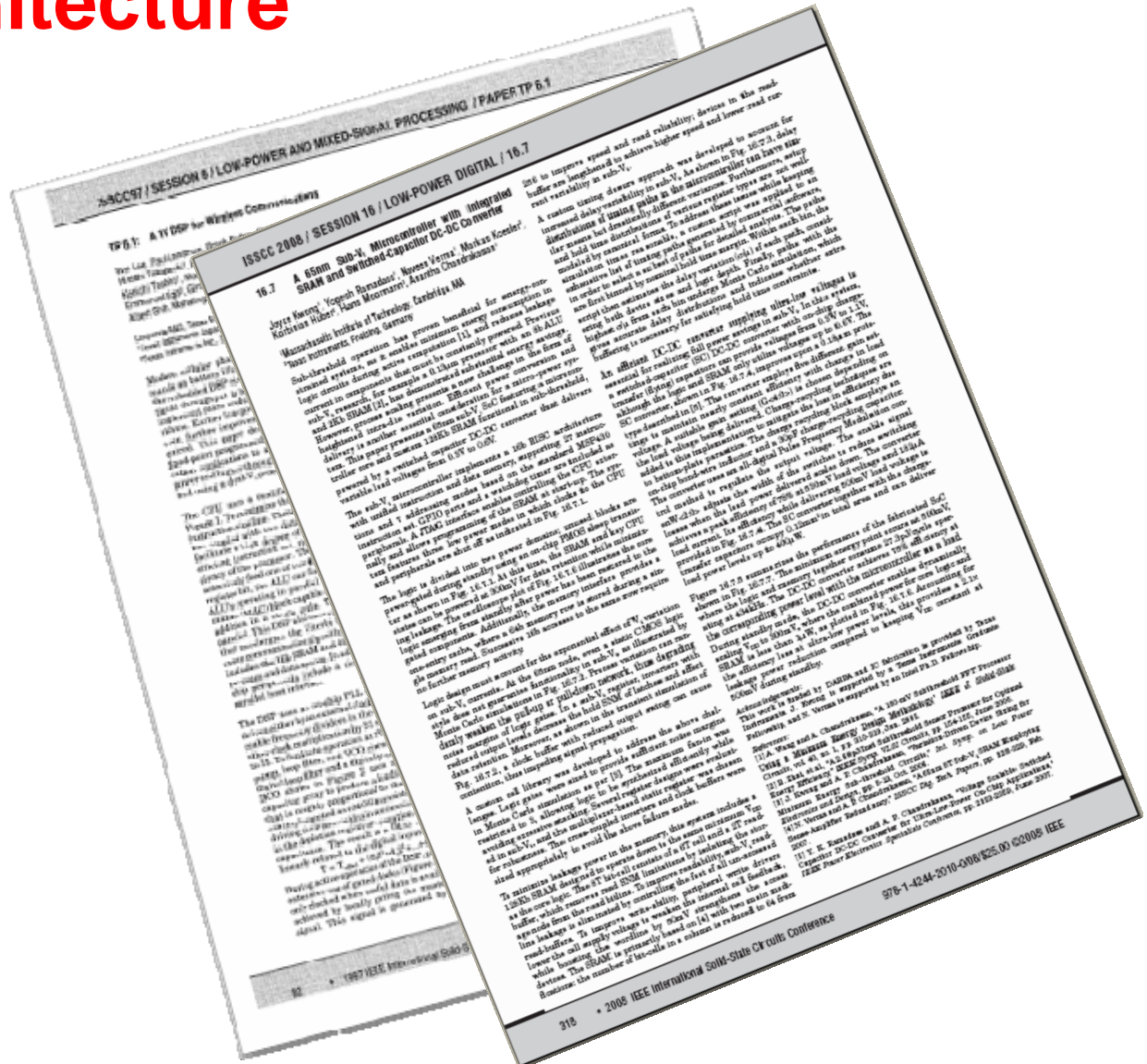
Pioneering research for complex, low-power processor architecture



Demonstrated first 1V DSP test chip in 1997



Demonstrated first 0.3V microcontroller in 2007



Analog power conversion: more from less



High efficiency

- >95% across operating range
- Very low current standby mode



High-density solution

- Very small external components
- Integrated power stage



High switching frequency

- Very fast response to load change
- Adaptive power modes

Available energy is all around

Light



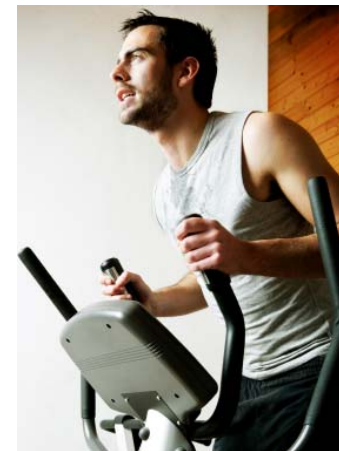
Radio frequency



Motion and vibration



Body heat

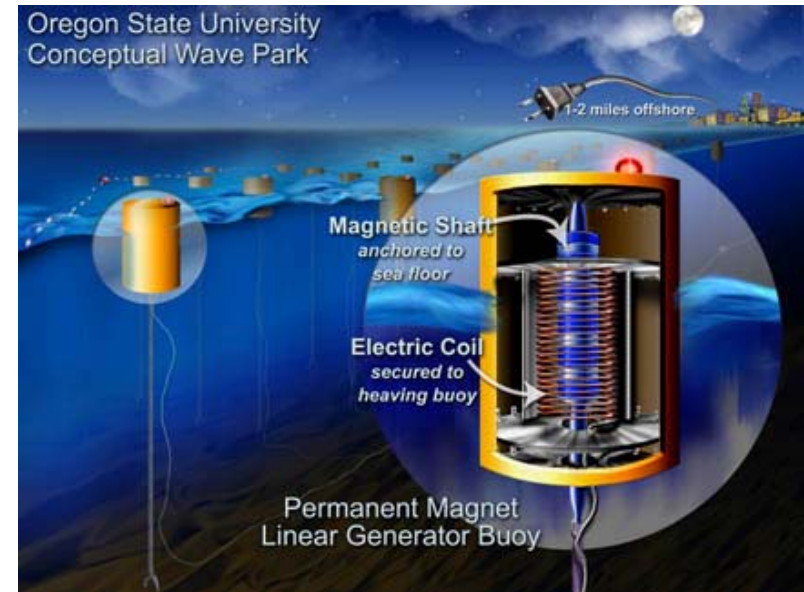


Energy harvesting exists today

Solar



Motion



Radio frequency

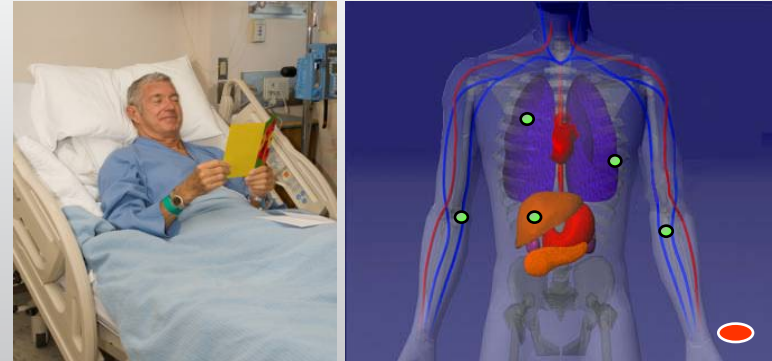


A future world without batteries or power cords

**Industrial wireless sensor network
(light, motion, RF)**



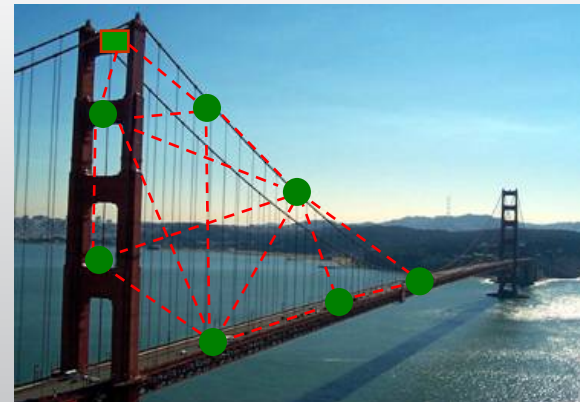
**Remote patient monitoring
(body heat)**



**Consumer wireless sensor networks
(light, motion)**



**Structural monitoring
(motion)**



Summary

- Systems approach to low power with leading digital and analog technologies today
- Driving tomorrow's solutions with research & development
- Low power/energy harvesting applications offer significant, long-term growth opportunity