

# Ultra Low-Energy Transceivers for Wireless Sensor Networks

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Tutorial

## Abstract

An untapped opportunity in the realm of wireless data lies in low data-rate ( $< 10$  Kbit/sec) low-cost wireless transceivers, assembled into distributed networks of sensor and actuator nodes. This enables applications such as smart buildings and highways, environment monitoring, user interfaces, entertainment, factory automation, and robotics. While the aggregate system processes large amounts of data, individual nodes participate in a small fraction only (typical data rates  $< 1$  Kbit/sec). These ubiquitous networks require that the individual nodes are tiny, easily integratable into the environment, and have negligible cost.

Most importantly, the nodes must be self-contained in terms of energy via a one-time battery charge or a replenishable supply of energy scavenged from the environment. With the proposed size limitations, battery power alone does not suffice to ensure self-containment. Energy scavenging approaches can deliver up to 100 microWatt. Achieving this ultra-low power-dissipation levels requires reductions from the system architecture down to the circuit technology. The presentation presents a number of techniques to accomplish this, and outlines venues for further research.