# Master Class I: Transiently Powered Computers
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Transiently Powered Computers (TPCs) are embedded computing machines that operate on harvested energy (for example through rectification of radio frequency radiation). TPCs attractiveness comes from the absence of manual recharge, making them "forever implantable" in any structure we can imagine. This pushes the boundaries of the Internet of Things (IoT) and enables richer data collection for the Big Data world from places still far away from the reach of classical (battery-operated) IoT devices.

In many implementations of TPCs (such as in open-source Wireless Identification and Sensing platform (WISP) [http://wisp5.wikispaces.com], see figure), communication with the outside world is performed by means of radio wave backscatter (as in the case any RFID tag). Backscatter is one of the most energy efficient communication technologies possible and the only viable communication technology for the TPCs given their low energy harvesting levels.
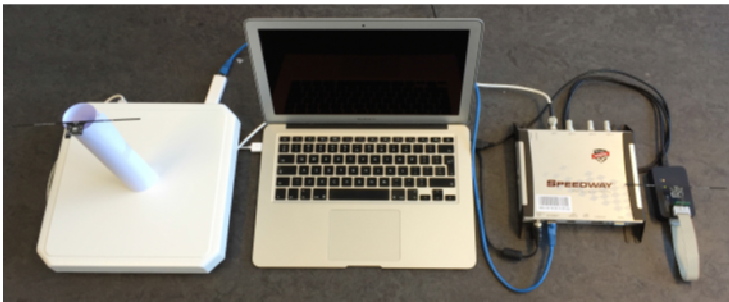
Because of the instability of power supply TPCs loose state every hundreds of milliseconds, preventing undisturbed computation and communication for prolonged periods of time. This eigenfunction of TPCs calls for new paradigms of thinking about systems: how to write programs that are aware of inevitable energy breakup, and how to communicate with the outside world in so minuscule power levels while being prone to high levels of interference. The goal of this module is to have a crash-course level understand on how TPCs operate, what are their applications, what are the challenges associated with them and how to simply make them usable for the IoT ecosystem.

Study Goals: To understand how battery-less energy harvesting backscatter systems work and to be able to create simple applications for them.

Master Class

- Introduction to battery-less computing
- Operation, ecosystem, frequency bands, types (active/passive, inductive/radiating)
- UHF RFID Readers: radio architecture, components
- RFID EPC Gen2 Standard: communication RFID tag/RFID reader
- LLRP protocol: communication RFID reader/PC
- WISP 5.0: hardware, software
- Application examples

Workshop

- Introduction to the class goals
- Analysis of EPC Gen2 Trace: Reader-Tag (Matlab/Octave/other type of text file plotting/importing tool needed)
- Control of RFID reader: formulating of EPC query at the reader for tag inventory (access to Internet needed, Python interpreter required)
- Programming WISP functionality: MSP Code Composer Studio required

Pre-existing knowledge required: Programming Embedded Systems (MSP430), programming in C and Python, basic understanding of electronics and radio communications.

Literature: Shyamnath Gollakota, Matthew S. Reynolds, Joshua R. Smith, and David J.Wetherall, "The Emergence of RF-Powered Computing", Computer, vol. 47, no. 1, pp. 32-39, Jan. 2014, http://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6671558