学位論文題目　A study of cellular and DTV RF energy harvesting and applications

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Ultra-low energy requirements are the key issue in pervasive ICT systems. Pervasive ICT systems must be capable of stand-alone operations and must be characterized by the absence of battery maintenance e.g. ambient sensors, wearable devices, and implantable medical systems i.e. energy autonomous systems. Most energy autonomous systems scavenge energy from the environmental sources such as mechanical, thermal, electromagnetic, and solar. This thesis focuses on electromagnetic wave source, particularly from cellular and Digital TV (DTV) base stations (towers).

From the study presented in this thesis, energy-harvesting will be useful for the growing integration of electronics into human lives and environments (the paradigm of pervasive computing). Looking at the current trends, micro- and nano-electronics do allow for ultra-low power designs making energy-harvesting power supply feasible. Ultra-low power systems could have extended performance by triggering stand-by mode (minimum active/duty cycle), and allowing for interrupt driven performance on demand, see Chapter 3: a demonstration on duty cycle control using programmable pulse width modulation (PWM) and stand-by mode trigger on Nordic chip radio using embedded C code control from micro controller unit (MCU) to radio chip, over serial peripheral interface (SPI). In general, energy-harvesting is proving to guarantee sustainability and energy autonomy in terms of longer life, avoidance of bulky batteries and providing the possibility for unprecedented applications, as discussed in this thesis.

In brief, Chapter 2 of this thesis describes the power supply realized from cellular and DTV signals, while Chapter 3 describes how to replace batteries with energy harvesting circuits. A system architecture for a sensor radio, powered fully from an energy harvesting supply is demonstrated, alongside other demos like motor drive for mechanical phase shifter control in cellular base stations. Chapter 4 discusses the more natural case of ultra low levels of RF power and how to effectively harvest such power and condition it for potential use in standard circuits. Chapter 5 introduces nanomaterials as a batteryless sensing candidate in order to eliminate the need to worry about power supply to the known electronic sensors. Conclusions are drawn in Chapter 6.