Monitoring and Control of a Dynamically Reconfigurable Wireless Sensor Node Powered by Hybrid Energy Harvesting

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For this demonstration, an accelerometer is attached to a wireless sensor node extended with a sensor data preprocessing unit based on a low-power FPGA (Figure 1). The processing functionality implemented by the hardware accelerator can be modified at run time by coarse-grained dynamic reconfiguration mechanisms (Figure 3). According to the remaining energy reserves in the node battery, one can take the decision to modify the accelerator configware in order to implement a simpler function. This will results in a lower energy consumption at the cost of measurements with lower quality.

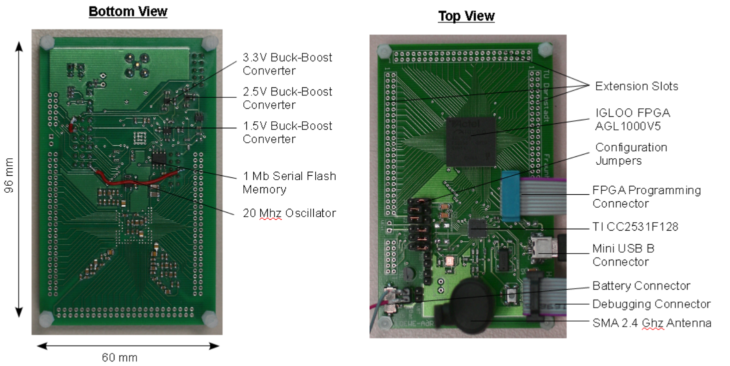

Figure 1 : HaLOEWEn
(Hardware Accelerated Low Energy Wireless Sensor-Actuator Node)

A second node is connected to a laptop running a Java application with Graphical User Interface. Accelerometer measurements, current energy reserves and a estimation of the current energy consumption of the first node are displayed (Figure 4). Furthermore, the current configuration of the accelerator can be managed though the interface. The user can select an alternative functionality that the hardware accelerator is able to implement. If so, the dynamic reconfiguration process is started : configware of the selected functionality is transmitted to the sensor node via the wireless link. The data is loaded into the accelerator configuration memory and normal operation is resumed. New results obtained from the sensor and accelerator are then updated on the Java Interface.

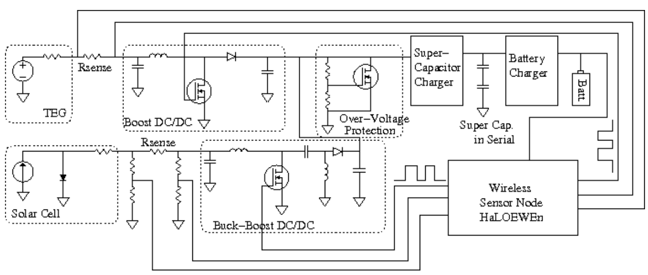

Figure 2 : Energy Harvesting Circuit

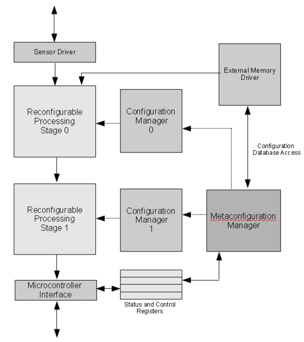

Figure 3 : Data Processing Reconfigurable Architecture

An energy harvesting circuit supplying the first sensor node is demonstrated as well. The energy is harvested from ambient energy sources through different transducers: solar panel and Peltier thermoelectric generators. The harvested energy is combined and stored in a super-capacitor. The energy is further transferred to a second storage lithium-ion battery. To adapt to the changing environment conditions, the maximum power point tracking algorithm is independently implemented for each transducer. The matching problem of combining different energy sources are considered in the design, and a good matching can be achieved when the generated power from different energy transducers are of similar level.

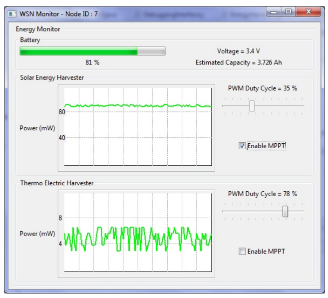

Figure 4 : Energy Harvesting Monitor GUI

For the demonstration, different environment conditions will be reproduced. The user is able to regulate the efficiency of the energy harvesting circuit through the Java control panel (Figure 4). Thus, the mechanisms of the maximum-power-point tracking are demonstrated.

Acknowledgments

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