SPACE EXPLORATION SYMPOSIUM (A3)
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LOW POWER LIGHTWEIGHT MICRO-METEOROLOGICAL STATION FOR WIRELESS SENSOR NETWORK BASED SPACE EXPLORATION

Abstract

Wireless Sensor Networks (WSNs) consisting of a large number of low power and lightweight micro-meteorological platforms represent an innovative approach to reliable environmental monitoring (tolerant to nodes failures) for planetary surface exploration. This paper presents the hardware improvements designed and developed in the frame of the European Union's Seventh Framework Programme SWIPE project (Space WIreless sensor networks for Planetary Exploration), towards obtaining a fully autonomous platform, both in terms of operation and power harvesting, which is at the same time compact and lightweight (below 2Kg).

Low mass, low power consumption and smart thermal regulation are three of the main objectives to be achieved when using solar energy as the main power source instead of Radioisotope Thermoelectric Generators (RTGs). Solar energy instead RTGs will significantly reduce the cost of each single node, thus

reducing the overall mission cost. The paper will present the micro-meteorological configuration structure and will describe the custom-made optimized sub-systems, including the Power Subsystem, On Board Computer, Radio Interface, complete scientific payload, and auxiliary subsystems for thermal regulation and platform deployment.

The design and development of the following two novel lightweight planetary exploration sensors, which are a part of the developed custom-made payload, will be outlined: i) A Dust Deposition Sensor (DDS) that will measure the micro-sized dust deposited by natural means during a certain exposition time. The total mass of the whole sensor is below 40 grams including an integrated actuator (based on Shape Memory Alloy (SMA) material) used for the dynamic calibration of the sensor; ii) a radiation sensor based on a mixed signal Application Specific Integrated Circuit (ASIC) that provides Total Ionizing Dose (TID) and Single Effect Upsets (SEUs) radiation monitoring over the planetary surface. This ASIC has been designed using radiation-hardening techniques. On the node bus side, an advanced Software-Defined Radio communications platform, with ad hoc networking capabilities, was the breakthrough element, designed in order to run the WSN algorithms efficiently and robustly.

Even though the node design has been developed for a specific mission, there is a lot of potential for any exploration mission in Space. The nodes have been developed using a modular approach, enabling to swap subsystems easily, without losing or majorly redesigning their functionality. This paper will also shed some light on the most promising applications in the future, which are able to take advantage of the node flexibility and adaptability to different environments and deployment techniques.