Paper ID: 15823
oral
student

19th SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Generic Technologies for Nano/Pico Platforms (6B)

Author: Mr. Danilo Roascio
Politecnico di Torino, Italy, danilo.roascio@polito.it

Prof. Leonardo M. Reyneri
Politecnico di Torino, Italy, leonardo.reyneri@polito.it

SOFTWARE DEFINED TRANSCEIVERS DESIGN IN NANO AND PICOSATELLITES

Abstract

The benefits offered by software defined radios (SDR) and the continuous advances in commercial digital electronics have triggered the interest of the nano and picosatellite community in advanced communication systems. In a field where, traditionally, well-known, in-flight tested and simple transceivers have been favored over innovative ones, the system architecture is mature enough to move to the next step. An increase in subsystem performance and complexity can now offer an efficient communication channel to loosen the constraints on the scientific goals and to better exploit the limited mission lifetime.

In communication subsystems, SDRs offer functionalities otherwise hard to achieve, like dynamic control of modulation parameters based on link conditions, complete in-orbit re-configurability, or integration of future technologies with limited subsystem re-design. This flexibility however comes at the expense of, generally, complexity and power consumption. While technology advances can somehow improve on both of them, the power requirements remain a major concern in nanosatellite missions. As of today, the software transceiver is still seen only as a payload or as a side mission, rather than a necessary building block of the architecture.

To tailor an advanced communication subsystem to the peculiar requirements of nanosatellite missions, a proper methodology is needed. This work shows how a careful planning of the communication parameters and a proper hardware partitioning minimizes and balances the overall energy requirements. And while the commercial availability of electronic components may limit the hardware alternatives, the same flow applied to the baseband software and a proper selection of algorithms allows for further performance vs. energy trade-offs.

A design case is presented and the criticalities in the planning and partitioning of the communication subsystem are outlined. The several choices in real-world electronic components and baseband algorithms are shown to affect, at a given performance level, the subsystem power consumption. The effects of a proper tuning to the mission requirements of an upcoming CubeSat mission are then analyzed in detail, with an actual implementation shown to match them, especially in terms of complexity (i.e., board area) and power consumption.

While not required per se by every nanosatellite, the use of software defined radios as the primary transceiver is shown to be affordable to most of them. The flexibility of such a transceiver represents an extension to the achievable mission objectives and, eventually, may become the mission itself, as recently shown by leading research projects like NASA's CoNNeCT/SCaN initiative.