Feasibility study of a Software Defined Radio and its adaptation to space

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This project is realized in the context of the development of the educative nanosatellites of the University of Liège (OUFTI). The OUFTI-1 nanosatellite is a CubeSat whose main payload is a D-STAR repeater. The AX.25 protocol and a beacon signal are used for remote control and telemetry purposes. These telecommunication protocols are basically implemented by three different hardware circuits, although the D-STAR and AX.25 protocols have certain parts of the signal path in common.

The goal of this project is to show that the hardware telecommunication system aboard the satellite can be replaced by a Software Defined Radio (SDR) system. The modulations/demodulations are in the actual system handled by hardware components while the encode/decode part of the signal processing is done by a microprocessor.

The principle of an SDR based system is to perform the modulation/demodulation tasks also by software. The big advantage of such an approach is the fact that the modulation/demodulation is soft-coded and thus changeable without the need of hardware modifications. The main disadvantage of the SDR technology is its power consumption that lies several magnitudes above the consumption of a classical hardware radio system. Other problems to consider are the reliability of the system and its vulnerability towards radiations.

In order to adapt an SDR to space, we use the RF front end of an Universal Software Radio Peripheral (USRP) by Ettus Research and we aim to perform the entire digital signal processing necessary for modulation and demodulation on a Spartan-3 FPGA. The protocols intended to be implemented are the AX.25 and the D-STAR protocols. The ultimate ambition is to perform a reconfiguration of the SDR ”in flight”, i.e. load a new protocol into the FPGA by sending it as a radio-modulated bit stream.

The major component of this study is thus the FPGA programming showing that the desired protocols can be implemented in an FPGA-based SDR. We will also show the possibility of space adaptation by choosing a set of hardware components that approaches the OUFTI-1 specifications in terms of power consumption, size, weight and robustness towards orbital conditions.