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# DEFINITION AND TESTING OF A SATELLITE-TO-USER RANGING AND COMMUNICATION SIGNAL FOR A MARTIAN NAVIGATION SYSTEM

**Abstract**

The increasing interest towards scientific and exploration missions targeting Mars is coupled to the need of developing a positioning and communication infrastructure capable of offering services to end users. In this framework, Argotec is working on a constellation of small satellites, focusing in particular on the key technologies enabling such autonomous telecommunication capabilities. This study defines an improved concept for a simultaneous communication and ranging satellite-to-user signal. The novel approach is based on Unbalanced-Quadrature Phase Shift Keying (U-QPSK) modulation and one-way Pseudo-Noise (PN) ranging, adapting the existing standards to the peculiar scenario of the mis-sion with the purpose to achieve a higher level of autonomy, while reducing the mission-related cost, weight, and bandwidth utilization. The identified solution was implemented and assessed as part of a technology demonstrator in a laboratory environment, running Digital Signal Processing (DSP) al-gorithms on Software Defined Radio (SDR) devices, thus emulating the behavior of the satellites and the final users, reaching a Technology Readiness Level (TRL) 4. The demonstrator validates the ability of the system to generate and transmit the navigation and communication signal modulated on the same channel using Code-Division Multiple Access (CDMA), and to correctly receive and process it to extract the ranging observables and to demodulate the communication data. This concept allows to achieve communication rates up to 64 kbps, and to determine estimates of range within few meters and of velocity within millimeters per second, thus fulfilling and exceeding the stringent requirements of future Martian missions by one order of magnitude.