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ADVANCES IN MODULATION AND COMMUNICATION PROTOCOLS FOR SMALL SATELLITE GROUND STATIONS

Abstract

Communication is key necessity for every space endeavour, nevertheless not much effort has been put into the development of communication protocols in the frame of small satellites yet. Mostly AX.25 is the protocol of choice, since it is widely supported by the amateur radio community and fairly easy to implement. In most small satellite missions commercial off the shelf hardware is used, only supporting AX.25 but no advanced protocols or modulation schemes as well as modification of modulation and protocol parameters. The growing need for higher data rates as well as the desire for more robust links requires more sophisticated communication protocols. With the rapidly evolving digital electronics Software Defined Radios (SDRs) become affordable for small satellite operators and are also widely used in the amateur radio community. Hence components that were traditionally designed solely in hardware and expensive to acquire can now be implemented in software instead and shared among the community. SDRs are thereby giving the opportunity to implement more advanced communication protocols and modulation schemes in software and at the same time still profit from the support of a large radio amateur community. The implementation of advanced protocols allows to include forward error correction and dynamic adaption of modulation parameters depending on the current link conditions. Thereby robustness and performance of communication links between satellites and ground stations can be increased in future missions. Some small satellite missions have already implemented such protocols but a general paradigm shift has not yet occurred among the community. SDR based ground station transceiver also allow for better signal analysis in case of bad link quality. GNU Radio was used for implementing different protocols and testing their performance on several SDRs. Design considerations as well as the lessons learned are briefly given. The applicability of low cost SDRs as a replacement for traditional radio equipment, mainly on the ground station side, is discussed and analyzed using real satellite transmissions. A SDR was therefore integrated in the UWE ground station system, running in parallel to the conventional radio chain. Furthermore the potential of advanced protocols was investigated in a testbed. The benefits and increased performance that are offered by advanced communication protocols are presented and compared to the traditional AX.25 protocol.