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Author: Mr. Andreas Hornig
University of Stuttgart, Germany, andreas.hornig@aerospaceresearch.net

LESSONS LEARNED DURING THE COMMISSIONING AND OPERATION OF THE GLOBAL DISTRIBUTED GROUND STATION NETWORK (DGSN) FOR THE AGILE TRACKING OF CUBESATS UNDER INTERNET-OF-THINGS (URBAN AND RURAL) CONDITIONS

Abstract

CubeSats and smallsats are revolutionizing the space industry with their new applications and their sheer numbers. The intention to deploy constellations of different magnitudes within the next decade is following similar fast, iterative and disruptive approach as do their cubesats' lifecycles. For tracking them and for communication with them, the Distributed Ground Station Network (DGSN) is in commissioning.

DGSN is a global network of groundstation for receiving radio-signals of CubeSats and other origins. Each groundstation is connected via the internet and thus the signals' origins can be determined. The stations are synchronized via GNSS (GPS,Galileo,...) and orbit-determination is performed by Time Difference of Arrival (TDOA) and further methods. The mission aim is to deliver orbital parameters for cubesats faster than existing sources (NORAD,ESTRACK) and enabling support of classical and completely new missions. This paper describes the lessons learned during the commissioning of the first 7 stations in Europe.

Special environmental conditions and challenges like influences due to local rf-emissions of radio services in urban and rural areas, as well as the influence on signalprocessing of typical repetative sequences (preambles) of modulation techniques for cubesats and other satellites are shown. During the postprocessing of demodulation of the raw-data, the paper shows typical effects on the integrity of the data on symboland bit-levels from APRS Audio Frequency Shift Keying mode, via weather-satellite data in Automatic Picture Transmission mode, up to satellites in Binary/Quadrature Phase Shift Keying modes. The identification of single errors on station level is used to detect corrupt stations in the network and solutions to improve tracking capability are shown. By applying Software Defined Radio (SDR), each DGSN groundstation is a versatile sensor with application in other frequency-bands. The usage of Open-Source expands the initial service of the basic rf-monitoring towards the services for planes (ADSB), ships (AIS), other vehicles, and other Internet-ofThings topics. By using our GROUND-SEGMENT-API, a unified and free interface, the coolaboration with third parties in a federated ecosystem is possible. The data-merging and the creative and agile expansion of the analysis is presented as well as the pros-and-cons of the system is explained to the user.

The DGSN project was started within the SmallSat-Design-Studies at the Institude of Space Systems (IRS), at the University of Stuttgart. It is part of the annual Google and ESA Summer of Code campaigns. And it is a PhD-research topic at the Institute for Photogrammetry (IFP) at the University of Stuttgart.