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RESULTS OF SATELLITE IDENTIFICATION AND POSITIONING BY PSEUDORANGING MEASUREMENTS TARGETTING ONLY RADIO TRANSMISSIONS PREAMBLES WITH HIGHLY-UNCERTAIN TIME-SYNCHRONIZATION AT THE GROUND-SEGMENT

Abstract

CubeSats and smallsats are revolutionizing the space industry with their new applications and their sheer numbers. The deployment of so many satellites together in super-clusters from one rideshare launch is creating new challenges to single satellite operators and ultimatingly to the full space traffic management. To reduce risk of collisions and space debris, and to allow operators to detect, identify and locate their satellites early, further collaboration between the operators and the tracking organizations is needed within the scope of the newly-forming Space Traffic Management.

By current state of the art identification and determination methods, it took about 5 weeks until the last of the 140 satellites that were deployed during SpaceX's Smallsat Rideshare Program mission "Transporter1" were fully listed on US-NORAD databases. To fasten this search up, the natural transmission of a satellite can be used to identfy and to locate their position. The radio transmission can be used as a finger print where the frequency and modulation are known features from ITU filings provide means of identifications. And most transmission modulations provide features that can be exploited for pseudoranging. This feature are preambles, or syncwords. And it can be used to beyond the synchronization of the payload data, it can also be used for common targeting multiple ground stations to sync and lock onto one signal and thus allowing pseudoranging. So current state-of-the-art rf-transmissions already provide everything for identifcation and positioning the satellite signal.

Within the scope of the Distributed Ground Station Network (DGSN) project, this paper will show results of the proof-of-concept for pseudoranging. The DGSN is a global network of groundstations for receiving radio-signals of CubeSats. It applies open-source methods to determine the origin of the rf-signal by pseudoranging from multiple stations and thus to determine the orbit. The DGSN uses commercial-of-the-shelf Software-Defined-Radio receivers that are synchronized via GPS/Galileo GNSS on ground-segment. The resulting uncertainty of time-synchronization of stations and signals poses a challenge for the pseudoranging. The identification and tracking performance is being evaluated by targeting known satellites like NOAA as a stand-in for other cubesats, smallsats or any other signal from Earth' orbit!

The DGSN project was started within the SmallSat-Design-Studies at the Institute 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.