19th IAA SYMPOSIUM ON SPACE DEBRIS (A6)
Joint Space Operations / Space Debris Session – STM Operations (10-B6.5)

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CHALLENGES WITH DATA-FUSION OF MIXED-INPUTS (DOPPLER-SHIFT, PSEUDO-RANGES) BY DISTRIBUTED GROUNDSTATIONS FOR FAST SATELLITE AND OBJECT TRACKING

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 ultimately to the full space traffic management. To reduce risk of collisions and space debris, and to allow operators to detect and identify their satellites early, further collaboration between the operators and the tracking organizations is needed within the scope of the newly forming Space Traffic Management.

Super-clusters with 140 and more individual satellites flying in close vicinity like those that were deployed during SpaceX's Smallsat Rideshare Program mission "Transporter1" pose challenges. Even with the first preliminary orbit data the identification of individual satellites can be ambiguous due the precision of the determined orbit data. The orbit bias of distance can be as high as the real distance between two satellites seemingly making the satellite switching position even though in reality they did not. Further knowledge is needed. With prior knowledge of the deployment sequence by the launcher, knowledge of special characteristics of the satellite active and passive radio and optical emissions and knowledge by the satellite operators' orbital knowledge themselves from on-board GNSS, that can be improved. But in general, faster identification is needed not only to start commissioning earlier and allow the new-space business models to be active and being profitable, but also to integrate the satellite into said Space Traffic Management network.

For this, the Distributed Ground Station Network (DGSN) is in commissioning. 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 data-fusion. With the DGSN, pseudoranging and doppler-shift is used from multiple stations to determine the orbits. The paper shows the challenges DGSN has encountered to identify satellite-candidates by combining the two inputs with the public ITU filings of the frequencies. Due to the open-source approach, further inputs like angles-only (RA/DEC), ranges, range-rates and onboard-GNSS coordinates can be included and up-scaling features by other organisations is possible and even fostered.

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.