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TRACKING ALL SATELLITES: ADDING TIME-SYNCHRONIZATION TO EACH
GROUNDSTATION IN A NETWORK DURING POST-PROCESSING BY APPLYING DATA FUSION
OF SIGNALS AND TIME-SOURCES**Abstract**

Cubesats and small satellites are revolutionizing the space industry and not only offering new space applications, but also leading to interesting new derivatives of of to use the ground segments. Software Defined Radio (SDR) is the driving force on the hardware side, the internet allows for easily connecting each groundstation to any groundstation network on a time shared basis, and cloud-services like Amazon's AWS is becoming the backbone on these networks.

During our Google Summer of Code (GSOC) work on the Distributed Ground Station Network (DGSN), an annual campaign organized by Google to foster the open-source community and make more open source software available for the benefit for all, big-data companies like them and others alike, it became obvious for us how to use already recorded and stored raw signal data (IQ-modulation) in post-processing to time-synchronize each ground-station just by its received signals. This will be used to track cubesats, as the main goal of the DGSN, and every other signal by time-differential-of-arrival (TDOA). This will be possible even without a GNSS-receiver integration being required at each station. The hybrid network of a few stations with GNSS in combination with stations without it will be required to share their received signal data.

The paper will show data-fusion techniques by using several sources of known signals as time-references between several stations like ADB-S for tracking planes without GNSS at all, like in hybrid mode for tracking NOAA satellites by their signals' preambles as common signal reference and GNSS providing the time-synchronnization for a few stations, or like tracking cubesats and the ISS bei their signals' payload contents in hybrid and full GNSS mode. The interesting part of the paper will be the presentation of the how to track satellites in one band and using the neighboring band's satelites for the time-synchronization of each station in post-processing. Furthermore it will be proposed to the cubesat community to transmit an ADSB-similar content like the orbitposition as a unique identifier and its opportunities for the full space community.

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. It is actively developed at several locations including a PhD-research topic at the Institute for Photogrammetry (IFP) at the University of Stuttgart.