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FROM GROUND TO SPACE: PROTOTYPE DEVELOPMENT AND EVALUATION OF THE TRACKING SYSTEM FOR SMALL SATELLITES WITH THE DISTRIBUTED GROUND STATION NETWORK

Abstract

The Distributed Ground Station Network (DGSN) is a novel network concept of small ground-stations and connected via the internet for performing automatic scans for satellite and other beacon signals. By correlating the received signal with the precise, GNSS synchronized reception times of at least five ground stations, it allows the positioning of the signal's origin. Thus a global tracking of small satellites becomes possible. It allows mission operators to position and track their small satellites faster after piggy-back commissioning, when the final orbit is yet undefined and could differ from the specified orbit. Furthermore it allows a permanent communication in "data-dump" mode. In this mode, DGSN ground-stations relay the received data to the central Constellation server and thus to the operator via the internet.

The core element of each ground-station is the timing-board. The timing board allows the determination of the local time of the system according to its position. This local system time is crucial for the correlation of the signal with the reception time. The DGSN tracking system faces two challenges with timing accuracy and with beacon signal reception. The timing accuracy of the system is influenced by several factors, such as availability of the GNSS time source, provided by the Global Positioning System (GPS) or the future Galileo satellites, and the dilution of precision caused by system parameters and the atmospheric parameters. The beacon signal reception is depending on the transmission link.

Before small satellites in Leo Earth Orbit can be tracked, a layered stage evaluation is applied in the DGSN development, which shall help minimizing the complexity and also allows the independent determination the performance parameters of the timing board, the beacon signal receiver unit and further components.

This paper describes the development of the essential GNSS based timing board and the layered multistage evaluation. The evaluation stages include ranging and pseudo-ranging techniques with single and multi-ground-stations configurations. The layered approach allows a controlled increase in beacon signal distance and encompasses ground based cartographic testing, air based atmospheric testing with quadrocopters and planes (ADSB), as well as near space and space based testing with high altitude balloons and cubesats. The DGSN project partnered with the Aerospace Lab Herrenberg and REXUS/BEXUS projects for tests onboard their experiments and is part of Google Summer of Code. The paper presents

further advantages of the open tracking service for small satellite operators and possible challenges of implementation and infrastructure operations.