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DISTRIBUTED GROUND STATION NETWORK - A GLOBAL SYSTEM FOR TRACKING AND  
COMMUNICATION WITH SMALL SATELLITES AS AN OPEN SERVICE

**Abstract**

Small satellite missions face two special challenges due to limited financial budgets. The first is tracking the satellite for orbit determination after orbit injection. The orbit can vary from the specified orbit when the satellite will be launched as secondary or parasitic payload. In case of unknown orbit parameters high-gain antennas can't be pointed towards the satellite and establish the first connection needed for satellite activation. The second challenge is to transmit all housekeeping and scientific data to mission operations via a limited number of ground-stations

The Distributed Ground Station Network (DGSN) solution can solve the problem with permanent tracking and a faster orbital element provision to the satellite owners. And it can provide permanent reception of satellite signals with its data-dump mode in between main ground-stations provided by the satellite owner. The key feature is the network of small ground-stations placed globally connected via the internet and performing an automatic scan of satellite (and other beacon) signals, storing and sending them back to a central server, where they can be accessed by the satellite owner. With a correlation of the beacon signal and GNSS synched ground-station time the satellite position is determined with pseudo-ranging trilateration.

In contrast to ground-station time sharing concepts of Radio Aurora Explorer (SRI International in California and University of Michigan), AISat (DLR) and QB50-GENSO (Karman Institute for Fluid Dynamics) that rely on a limited number of amateur radio operators and expensive hardware with limited availability DGSN uses an innovative citizen science approach. The participatory aspect includes the deployment of ground-station hardware and acquisition of satellite signal data but also the open-source hardware. In this way a high number of built sensor-nodes can be achieved and it also creates a new market for selling ready ground-stations.

The network offers an open-platform for every small satellite operator with a faster access to tracking data than the update period by NORAD or ESTRACK with less running costs. The low data-rate reception is compensated by the global and permanent coverage. DGSN will offer the orbital parameters of the received satellite signal under a free license.

The feasibility study had been conducted as part of Azorean observing VERDE Sat during the "Small Satellite Project" at the Institute of Space Systems (IRS) of the University of Stuttgart and DGSN is in the prototyping and testing phase of the ground-stations.