IAF SPACE COMMUNICATIONS AND NAVIGATION SYMPOSIUM (B2)
Mobile Satellite Communications and Navigation Technology (4)

Author: Mr. Paolo Marzioli
Sapienza University of Rome, Italy, paolo.marzioli@uniroma1.it

Mr. Lorenzo Frezza
Sapienza University of Rome, Italy, iverie19@gmail.com
Mr. Diego Amadio
Sapienza - University of Rome, Italy, amadio.1200335@studenti.uniroma1.it
Dr. Francesco Santoro
Altec S.p.A., Italy, francesco.santoro@altecspace.it
Mr. Cristoforo Romanelli
Altec S.p.A., Italy, cristoforo.romanelli@altecspace.it
Dr. Fabrizio Piergentili
Sapienza University of Rome, Italy, fabrizio.piergentili@uniroma1.it
Prof. Fabio Santoni
Sapienza University of Rome, Italy, fabio.santoni@uniroma1.it

# INNOVATIVE TRACKING SYSTEMS TEST ON-BOARD A STRATOSPHERIC BALLOON: THE STRAINS EXPERIMENT

**Abstract**

The future rise of stratospheric and suborbital aviation shall consider the introduction of innovative surveillance and navigation systems for optimizing integration with the conventional civil aviation flights, while maintaining adequate safety rates of all the planned operations. Currently, commercial and civil aviation vehicles surveillance relies on active systems, i.e. radars, while data fusion among inertial, satellite and radio-based systems is exploited for navigation purposes. Recent research trends have led to passive tracking techniques testing, relying on multiple ground-based receiving stations exploitation and on precise data fusion and processing techniques. Among all, the most promising techniques are the Time-Difference-of-Arrival (TDOA) and the Frequency-Difference-of-Arrival (FDOA). The TDOA relies on the estimation of the reception times from multiple ground stations of a radio-frequency pulse transmitted by a target at an unknown time. The reception times are compared and integrated to provide an estimation of the target position. The FDOA consists in evaluating the Doppler shift frequency and the radial velocity of the target with respect to multiple ground stations. The measured radial speeds are integrated to provide an estimation of the target velocity vector. These tracking methods present a great potential for being implemented in stratospheric and suborbital vehicles tracking, represented by their passive nature, the low implementation cost, high reliability, non-dependability on the single station well-functioning. The STRAINS Experiment (Stratospheric Tracking Innovative Systems) is a stratospheric experiment proposed by Sapienza University of Rome (Rome, Italy) and ALTEC (Aerospace Logistics Technology Engineering Company, Turin, Italy) selected for the 2018 call of the HEMERA H2020 balloon infrastructure project. The experiment is aimed at testing TDOA and FDOA for a stratospheric balloon flight, to be launched from the Esrange Space Center (Kiruna, Sweden) in 2020, and comparing the relevant outcome. The stratospheric experiment features low-power transmitters and reference position instrumentation. At least five ground stations will be set in the launch area to test the TDOA and FDOA tracking precision. Additionally, the balloon will be tracked by integrating a motorized antenna pointing

angles, with the measured Doppler shift information. This paper will describe the mission concept, the architecture, the objectives and the expected results from the STRAINS project. After an overview of the new tracking techniques to be tested, the experiment design will be described in detail. The balloon experiment planned operations and expected results for each technique to be tested will then briefly presented, with an overview of the applicability of the proposed research.