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INTERNET-OF-THINGS SENSOR APPLICATIONS ON THE SAPIENZA S5LAB CUBESATS: FROM WILDLIFE MONITORING TO INTER-SATELLITE LINK RESEARCH

Abstract

Internet-of-Things (IoT) technologies provide the chance to fly low-power transceiving and in-situ monitoring applications to nano-satellite platforms. In this framework, Sapienza Space Systems and Space Surveillance (S5Lab) research group at Sapienza University of Rome has been developing two nano-satellites with payloads aimed at testing IoT payloads for various applications. The ongoing work on WildTrackCube-SIMBA, developed by Sapienza University of Rome in coordination with ASI, in collaboration with Machakos University and the University of Nairobi, allowed the progress in multiple scientific and technology fields. The satellite has been launched on March 22nd, 2021 thanks to a launch opportunity offered by the International Astronautical Federation and by GK Launch Services and it is operational in-orbit. The main mission objective is to validate new IoT techniques for satellite-based wildlife tracking by using spread-spectrum radio technology. During the mission execution, the IoT ground-to-space link has been in-depth analyzed until achieving the optimization of the ground-based wildlife collars design and operations. Additionally, SIMBA is being used to further research in IoT technologies for space applications, pushing towards a future application on Inter-Satellite Links (ISL), which can lead to the chance of low-power, low-cost satellite communication even when not in visibility with the ground station. As a first enabling step for ISL achievement, tests have been performed between SIMBA and the LEDSAT CubeSat (another CubeSat developed by S5Lab and launched in 2021) using standard radio technology. The knowledge acquired in the IoT and ISL link segments can be exploited to obtain an "easy-to-implement" IoT telemetry link with satellites, with little compromises in terms of cost and power budget, but also a backup method in case of failure of the main TTC subsystem. To

this end, a new project named CORAL is being developed, with the production of a 2U nano-satellite to be launched in 2024, by Sapienza University of Rome in a collaboration between Thales Alenia Space Italia and Telespazio and with the support of ESA. The project objectives aim at testing the spread-spectrum-based ISL with SIMBA and other targets using the acquired knowledge of the IoT technologies. This paper will describe the S5Lab achievements in nano-satellite IoT payload applications. After an introduction on the IoT implementation on CubeSats, the results obtained with the WildTrackCube-SIMBA in-situ wildlife monitoring sensors, the extension to ISL through the operations of LEDSAT and the future spread-spectrum ISL testing campaigns to be performed by CORAL will be in-depth analyzed and presented.