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Enabling Open and Remote-Access Sensing on Small Satellites

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It is not new that satellite design, component procuration, integration, testing, launch and operation are cost and time demanding. However, during the last decade, the small-satellite concept re-emerged not only as an enabler of smaller and lightweight platforms, but also as a new aerospace paradigm based in a) the adoption of up-to-date consumer technologies, b) rapid development cycles and c) small agile teams operating closer to IT industry management models rather than those found in traditional military/aerospace organizations.

In this context, we further push the paradigm to propose Open and Remote-Access Sensing (ORAS) as a mean to share the utilization of in-orbit resources of a small cubesat among several users with autonomous and potentially isolated ground stations. The ORAS concept and the specifics of a mission currently under design to implement it are product of a joint effort of professor and students of master on Satellite Instrumentation course held at the Gullich institute, within the Argentinian Space Agency (CONAE) in Córdoba, Argentina.

The main driver behind the ORAS project is the fact that state-of-the-art technology for modern small platforms tend to provide large storage and processing capabilities, but limited downlink data-rate, typically constrained by available in-orbit power and limited antenna gains. Indeed, both the placement and accurate pointing of a high-gain antenna as well as energy harvesting via solar panels within the size of a cubesat are difficult endeavours. As a result, the downlink communication channel quickly becomes a bottleneck hindering the efficient use of the platform.

To balance and improve the utilization of valuable in-orbit resources we propose ORAS: an open-access strategy where satellite's instruments are accessible to as many users as possible. This allow any ground station equipped with a standard communication hardware publicly available in the market to access, command, manage and download instrument acquisitions. In particular, an acquisition might be executed and previewed via thumbnails by users but not necessarily downloaded. As a consequence, the downlink channel utilization is better utilized and extended for as many users interested in the observations thus widening the resource bottleneck and maximizing the scientific return of the orbiting object.

Nonetheless, challenges to successfully achieve ORAS are not minor. Allowing anyone anywhere to access the satellite requires of non-trivial but highly developed protocols that a) provides secure access to authorized and authenticated users to command specific and carefully chosen functions of the platform and b) ensure a correct utilization of observation resources by keeping and administering an in-orbit schedule and avoiding battery-power exhaustion. Since the mission control cannot be continuously in contact with the cubesat, all these functionalities need to be performed autonomously in the cubesat.

Besides describing in details how these unprecedented challenges can be tackled, this presentation discusses how a specific cubesat mission can implement the ORAS concept by making use of Components Off The Shelf (COTS) in redundancy and leveraging fault-tolerant architectures to increase the reliability of the system to meet the expected lifetime of the mission. We analyze the case of an instrument devoted to observe termic-sensitive events on the surface, a thermal camera which allows to monitor thermal anomalies and warn of possible emergency situations. In particular, we discuss the monitoring of volcanic activity on the Andes mountain as a motivational example.

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