Strategies to Reduce Power Consumption in pico-Satellites

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Abstract — To assess and rehabilitate degraded forests are global challenges. Due to the various causes and severity of degradation, they typically show a very diverse structure, which makes acquiring a detailed inventory, as a first step toward rehabilitation measures, difficult and costly. Area-based inventories based on satellite imagery are a well-established methodology to assess and classify the forest cover, but the information obtained is often not detailed enough to fulfil the needs of site-adapted rehabilitation in degraded forests with a highly diverse structure. Furthermore, due to the great variability of the forest structure, a great number of ground sample plots are necessary to establish statistically sound predictions of structural parameters. We propose to test a real mission in Azores Island, based on the typical pico-satellites architectures, after provide some strategies to create a new architecture design and predict power consumption, based on the sentences of low-power, very small scale, low-cost and very integrated system.

Keywords — pico-Satellites, Reduce Power Consumption, ESP32, Raspberry Pi, Microcontrollers, Very Small Scale, Low-Power, SoC, Predictive Model; Data Mining

I. INTRODUCTION

New technologies, such as Unmanned Aerial Vehicles (UAV) or balloons or pico-satellite – CANSAT missions, allow the acquisition of detailed images, but until now they are mostly used to estimate forest attributes only in small scale applications, and if a precise Digital Terrain Model (DTM) is available, since optical sensors cannot sense terrain under dense canopy covers. However, the frequent canopy gaps on degraded forests would allow the partial assessment of the terrain, and the combination of wall-to-wall satellite imagery with partial cover UAV imagery would allow larger scale inventories of acceptable accuracy and reliability without the need for an increased number of ground sample plots. Another fundamental part is integrate radio communications part in UAV, balloons like it use in pico-satellites, so it means that not only the process to put in the air and stay (UAV, balloons or pico-satellites) to covered some area is important, but also the capacity to communicate to the ground or between the "air devices" and Internet of Thing (IoT) all the conditions to be integrated in that devices using standard cellular radio technology like 3rd Generation Partnership Project (3GPP). Recognizing the importance of IoT, 3GPP has introduced a number of key features for IoT in its latest release, Rel-13. EC-GSM-IoT [1] and LTE-MTC [2] aim to enhance existing Global System for Mobile Communications (GSM) [3] and Long-Term Evolution (LTE) [4] networks, respectively, for better serving IoT use cases. Coverage extension, complexity reduction in the devices, long battery lifetime, and backward compatibility are common objectives. A third track, Narrowband Internet of Things (NB-IoT) [5], shares these objectives as well. In addition, NB-IoT aims to offer deployment flexibility allowing an operator to introduce NB-IoT using a small portion of its existing available spectrum. NB-IoT is designed mainly targeting ultra-low-end IoT applications. NB-IoT is a new 3GPP radio-access technology in the sense that it is not fully backward compatible with existing 3GPP devices. In this paper we present results about a real mission, based on CANSAT concept, in Santa Maria Island in Azores and we discuss about other new technologies focus on low-power, low-cost, very small scale and technologies that support reconfigurable part to give more modularity in the hardware and a very integrated.

II. SYSTEM ARCHITECTURE

The CANSAT (satellite shaped tin) is a functional model of a pico-satellite, in that all electronics systems are integrated into the volume of a soda can. It is launched by a rocket to a predefined altitude (1000 meters) so that during the descent is possible to carry out a scientific experiment, to capture the emitted signals (telemetry) and ensure a safe landing. So, the CANSAT Portugal is an educational project of ESERO Portugal, organized by the European Space Agency (ESA). This initiative enables the design and build a functional model of a pico-satellite whose base systems (antenna, battery and sensors) will have to be integrated in a volume equivalent to a can of refrigerant, this model has two missions, where the primary mission is measurement of air temperature, atmospheric pressure and altitude during the descendent and transmit the parameters to an earth station, using radio communications 433MHz. The secondary mission is to obtain a 3D ground mapping of the surface of Santa Maria Island in Azores. We also associate, in each photo, data coming from the GPS signal (Latitude., Longitude Altitude, Speed and Time), atmospheric pressure and temperature sensor. So, our 3D mapping is not only based on images, latitude altitude and longitude, as the common 3D mapping. To do that task, we include two 8M pixels RGB cameras in the satellite to take, simultaneously, photos. The cameras are in different places on the can, one in front and other on the downside of the can. The gold of this scientific mission (secondary mission) was using the parameters described previously, we intend to analyze: the relief, biodiversity and its fauna and flora. This knowledge helps in deforestation, species control and terrain mapping with the intention of inspect regularly and using an easy way, like our secondary mission. The project is directed to the environmental aspect in order to take care of the ecosystem of the Island of Santa Maria in Azores.

This kind of mapping can also be helpful to the forestry supervision. With detailed maps, illegal logging can be de-