Paper ID: 77750
student

IAF EARTH OBSERVATION SYMPOSIUM (B1)
Interactive Presentations - IAF EARTH OBSERVATION SYMPOSIUM (IP)

Author: Mr. Francesco Valente
Sapienza University of Rome, Italy, francesco.valente@uniroma1.it

Dr. Francesco Giacinto Lavacca
Sapienza University of Rome, Italy, francescogiacinto.lavacca@uniroma1.it
Dr. Marco Polverini
Sapienza University of Rome, Italy, marco.polverini@uniroma1.it
Prof. Vincenzo Eramo
Sapienza University of Rome, Italy, vincenzo.eramo@uniroma1.it

A RESOURCE ALLOCATION STRATEGY IN ORBITAL EDGE COMPUTING EARTH OBSERVATION SATELLITE CONSTELLATIONS TO JOINTLY SAVE ENERGY ON GROUND AND BALANCE ON-BOARD ENERGY CONSUMPTION

Abstract

Earth Observation (EO) satellites currently acquire images to be then stored in their on-board memory, until they fly over a ground station, when they shall transmit a high amount of data in a short time. Thus, a high data rate is requested, but this is constrained by the power available on-board, in turn limited by the dimensions and masses of solar panels and batteries. However, not all data transmitted to the ground are actually useful to the application. A solution can be obtained by endowing satellites with on-board processing capacity and Inter-Satellite Links (ISLs) to make them able to offload data processing to other satellites whenever they have not enough resources to accomplish the processing task. This would allow for an on-board extraction of the useful information from acquired images, leading to an increased efficiency in bandwidth usage and to a reduction of both the time needed to deliver information to the ground station and of the energy to be used by ground stations to process information. However, transmission, storage, and computational capacity available for in-orbit processing are valuable resources and could be not always available. For this reason, it is necessary to design strategies to appropriately allocate bandwidth and processing resources on satellites and to leverage the possibilities opened by the network of satellites made possible by ISLs, while optimizing a desired metric. In particular, in this work we focus on minimizing the ground station energy consumption due to image processing while assuring that the energy consumption of satellites within the constellation is appropriately balanced. This arises from the fact that in EO satellites energy is allocated in advance by endowing them with appropriate solar panels and batteries, and this amount of energy is always generated, even when it is not necessary, while energy consumption on ground station is closely related to its demand. We evaluate the performance of the proposed strategy with respect to two benchmark solutions, one representing the current operation scheme of EO missions, and the other providing for processing to happen either on the satellite which acquired the image or on ground. Results show the effectiveness of the proposed solution in reducing the amount of energy required to ground stations to process images while guaranteeing a balanced energy consumption within the constellation, considering time-varying available energy on satellites due to batteries charge and discharge and power generation cycles.