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UTILISING DISTRIBUTED PROCESSING TO REDUCE THE POWER CONSUMPTION OF MULTIPLE GNSS RECEIVERS IN A SATELLITE CONSTELLATION

Abstract

With the reduction in the size of technology, the ability of pico-satellites, such as Cubesats, to perform meaningful tasks in satellite constellations is increasing. However, the cost of developing and manufacturing a Cubesat is still significant, limiting the size of a potential constellation. It has previously been suggested [1] that a constellation of satellites on a printed circuit board (PCBsats), could perform a significant subset of these tasks at a substantial reduction in cost, both in terms of manufacturing and launch costs. These PCBsats are femto-satellites measuring 10x10x2 cm and are based around a single printed circuit board (PCB), but have the limitation of a reduced power budget. As a practical consequence of this, it is not possible for the PCBsats to communicate directly with a ground station, instead requiring a relaying satellite, such as a Cubesat, to provide a ground-link.

A typical GNSS receiver consists of two distinct modules - the tracking channels, that acquire and track the different satellite signals, and the navigation processor, which calculates the position of the receiver from the decoded data. Whilst the tracking channels have to be located at the receiver, there is no requirement for the navigation processor to be. There is, additionally, no requirement for how long the delay is between the signal reception and the position calculation.

In this paper, we will present the design of a GNSS receiver that utilises distributed processing, for use in a combined pico- and femto-satellite constellation. Where the navigation processors of many individual receivers (located on the PCBsats) are combined onto the relaying satellite (Cubesat). This has the potential advantage of reducing the power consumption of the GNSS receivers on the PCBsats, allowing for more power consuming payloads. Whilst the combined navigation processors provide a higher precision solution, due to the Cubesat's higher power budget. Initial estimates, with the navigation processor acquiring and caching each satellite's ephemeris, suggest that this approach could potentially reduce the power consumption of the individual GNSS receivers by up to 30

There are, of course, drawbacks to this approach, such as increased satellite search times and constraints on the separation of the satellites in the constellation, that will be discussed in depth.

[1] - D. J. Barnhart, T. Vladimirova, A. M. Baker, M. N. Sweeting, "A low-cost femtosatellite to enable distributed space missions", Acta Astronautica 64(11–12), 2009. doi: 10.1016/j.actaastro.2009.01.025