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SMALL SATELLITE MISSIONS SYMPOSIUM (B4)
Small Satellites Potential for Future Integrated Applications and Services (4)

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SYSTEMATIC IDENTIFICATION OF APPLICATIONS FOR A CLUSTER OF FEMTO-SATELLITES

Abstract

Embracing reduced requirements and leveraging commercial technology has led to a fast growing small satellite industry. Although most interest in small satellites has hovered around the micro-satellites through to the pico-satellites, academic interest now extends up to the sub 100 g range of satellites as well. Femto-satellites with a mass range between 10 g and 100 g could in the future be mass produced and hundreds to thousands of femto-satellites can be deployed as a cluster to enhance, for example, the situational awareness of the Earth's environment.

Femto-satellite is seen to form the next class of miniature satellites which will exploit spacecraft engineering, swarm science and mission design to realize exciting new space missions. Consequently, there has been considerable research interest in the sub 100 g range of satellites and the advantage of distributed satellites in space. However, most of the research work has been limited to a bottom-up approach to realize an individual femto-satellite with as much functionality as possible, without sufficient attention to the realization of an application using these distributed femto-satellites in space. This has resulted in an ambiguous top tier of space applications whose realization with a cluster of femto-satellites is arguable.

The aim of this paper is to precisely map the user requirements for applications to the scaled capability of a cluster of femto-satellites, thereby aiding to systematically identify potential applications for femto-clusters. The principal challenge is that there exists no simple means to scale the capability of an individual femto-satellite to the capability of a distributed cluster of femto-satellites. In this study, the capabilities of a femto-satellite that can be scaled are identified and the scaling ratios are derived. Generic laws applicable to all scenarios are established where possible. However, scaling certain capabilities is not straightforward. For example, when we consider a user requirement such as orbit control, the inherent virtue of a distributed system may obviate the need for orbit control in individual satellites for some scenario and may not in other cases. These functionalities are carefully considered to develop qualitative and quantitative metrics that enable the scaling of individual satellite capability to the overall capability of a cluster of satellites.