

SPACE SYSTEMS SYMPOSIUM (D1)
Innovative and Visionary Space Systems Concepts (1)

Author: Dr. Jian Guo

Delft University of Technology (TU Delft), The Netherlands, J.Guo@tudelft.nl

Prof. Eberhard Gill

Delft University of Technology, The Netherlands, E.K.A.Gill@tudelft.nl

Mr. Daan Maessen

Delft University of Technology (TU Delft), The Netherlands, D.C.Maessen@tudelft.nl

FRACTIONATED SPACECRAFT: THE NEW SPROUT IN DISTRIBUTED SPACE SYSTEMS

Abstract

The fractionated spacecraft is a novel architecture for distributed space systems. Unlike constellations or formations where similar spacecraft are spatially distributed, the fractionated spacecraft distributes the functional capabilities of a conventional monolithic spacecraft amongst multiple heterogeneous modules which perform distinct functions and interact through wireless communication links. Although arguments on its economics still exist, the fractionated spacecraft is attracting more and more attention from academia, industry and governments due to its advantages of rapid response, enhanced mission and in-orbit robustness, potential for mass production, flexibility with later added features and lowered mission recovery costs. In some sense the fractionated spacecraft can be regarded as a game-changing event in the history of space systems, just like the internet revolutionized data communications.

Although “fractionated spacecraft” is a relatively new term that has been coined in 2006, much work has been done or is ongoing in this field. This paper attempts to provide a comprehensive view of current state-of-the-art technologies related to fractionated spacecraft, including the work being performed at the Technical University of Delft (TU Delft), the Netherlands. The paper consists of two primary parts. The first part is a survey of up-to-date research on fractionated spacecraft. As a truly networked system of systems in space, the fractionated spacecraft faces a lot of challenges, such as wireless inter-module communication and power transfer, autonomous self-forming networks, cooperation between modules and so on. Recent progresses in these technologies are reviewed in the context of distributed space systems, but with the focus on their availability for fractionated spacecraft. Special focus is put on ongoing or planned space missions related to fractionated spacecraft (for example Pleiades). The second part of this paper introduces the relevant research and development activities at TU Delft. Currently, the work of the Space Systems Engineering Group of TU Delft focuses on distributed space systems, especially on two micro-/nano-satellite formation flying missions, i.e. FAST (Formation for Atmospheric Science and Technology demonstration) and OLFAR (Orbiting Low Frequency Antenna for Radio astronomy). However, as an emerging branch of distributed space systems, the fractionated spacecraft in some sense shares some technologies with formation flying, such as wireless communication, relative ranging, networking, collaborative operation of the cluster and distributed computing. TU Delft’s RD work in these aspects and the possible extension to fractionated spacecraft is presented, followed by lessons learned, conclusions and recommendations.