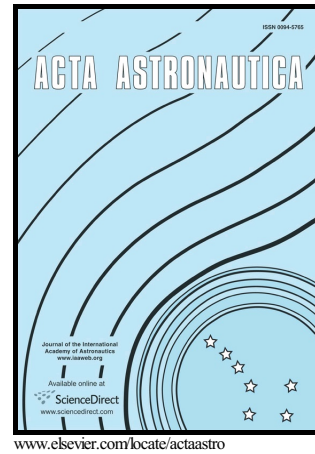


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Fundamentals of the Route Theory for Satellite Constellation Design for Earth Discontinuous Coverage. Part 4: Compound Satellite Structures on Orbits with Synchronized Nodal Regression[★]

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Basing on the theory results considered in the previous papers of the series for traditional one-tiered constellation formed on the orbits with the same values of altitudes and inclinations for all the satellites of the constellation, the method for constellation design using compound satellite structures on orbits with different altitudes and inclinations and synchronized nodal regression is developed. Compound, multi-tiered, satellite structures (constellations) are based on orbits with different values of altitude and inclination providing nodal regression synchronization. It is shown that using compound satellite constellations for Earth periodic coverage makes it possible to sufficiently improve the Earth coverage, as compared to the traditional constellations based on the orbits with common altitude and inclination for all the satellites of the constellation, and, as a consequence, to get new opportunities for the satellite constellation design for different types of prospective space systems regarding increasing the quality of observations or minimization of the number of the satellites required.

Keywords

Satellite Constellation; Constellation Design; Discontinuous Earth Coverage; Compound Satellite Structures; Synchronized Nodal Regression.

1. Introduction

For many years since the beginning of space era the satellite constellations, both for continuous and discontinuous (periodic) Earth observation missions, have been designed using orbits with common values of altitude and inclination for all the satellites in the constellation. The reason is quite understandable: if the values of two mentioned parameters are different for the satellites in the constellation, the orbital structure, in common case, becomes unstable due to different nodal regression and an extra delta-V (fuel) budget on-board the satellites is required for constellation station keeping. Due to this reason almost every known solution for design of satellite constellations for coverage of large Earth regions is based on the use of circular orbits with equal altitudes and inclinations.

In this paper a method for constellation design for Earth periodic coverage using compound satellite structures on orbits with different values of altitude and inclination of the satellites in the constellation is developed. It is the generalization of the theory results considered in the previous papers of the series [1-3] for traditional one-tiered constellation formed on the orbits with the same values of altitudes and

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