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

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A "LAYERED PIE" IN NEAR-EARTH SPACE: A CONCEPT OF A UNIVERSAL HYBRID SATELLITE SYSTEM, ALGORITHMS OF FUNCTIONING AS A GIANT FINITE AUTOMATON

Abstract

Trends of development of satellite systems lead to a prototype of a united, jointly used system combining those existing and forthcoming that would develop as a systemic structure of the highest hierarchy level. Two trends are essential: 1) Development of each project of a satellite system as a "brick" of the future united system; 2) Development of a universal hybrid satellite system of the highest hierarchy level. A concept with the following main provisions is proposed. The orbital constellation of the system is a set of sub-constellations (segments) in various altitudes with quasi-global coverage of Earth. Segments form "layers" of both structurally united and autonomous satellites. The system comprises subsystems of various purposes. Each subsystem, generally, comprises several constellations in different altitudes. Inter-satellite communication is implemented within each subsystem and on the entire system level. There are data transportation subsystems; subsystems providing data processing (cloud computing) and/or storage; subsystems for remote sensing of Earth, monitoring of the atmosphere and near-Earth space. Their functioning is based on unification of technologies of data acquisition and primary processing (the internet of things, fuzzy computations) and can use services of data transportation and cloud computing, navigation subsystems and subsystems providing servicing of spacecraft of other subsystems and prevention of mechanical conflicts. Further, subsystems for interplanetary communication and product manufacturing will emerge. Communication networks of the majority of subsystems are relieved from transmission of service data by the segments the spacecraft of which obtain information on the current state of the subsystem and broadcast it to all spacecraft of the subsystem using technologies similar to those used in navigation systems. Similarly, all-system information is broadcast. A notion of data storage load of a spacecraft was introduced. The storage was divided into levels of filling-in, and the load is the number of the levels being filled in. Satellites of the system maintain onboard and update via communication information on its other elements and indicators of the load of other subsystems. Algorithms of reaction of an element to external inputs depend on its current state and states of other elements. The whole system is considered as a giant finite automaton. The tasks are divided into sub-system and all-system ones and into kinds with a, generally, dynamic, hierarchy level. Generalized algorithms of functioning of the described system are proposed. A simplified simulation model of the system was developed.