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

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GLOBAL SATELLITE SYSTEMS BASED ON CLUSTER GROUPS: TWO CONCEPTUAL DECISIONS, THEIR SYNERGETIC AND COMMUNICATION IN SYSTEMS

Abstract

Consider two trends in development of satellite systems: 1) the use of various types of cluster groupings of spacecraft (clusters of the "distributed spacecraft" type, and relatively "rarefied" cluster groups); 2) a comprehensive solution to the problems of communication, remote sensing of the Earth and observation of near-Earth space based on global systems. Satellite systems built on a multitude of cluster groupings are becoming ever more promising. From the viewpoint of saving energy on orbit correction, clusters with a dynamic ("sliding") composition are effective (spacecraft drift from cluster to cluster due to uncorrectable changes in their position relative to other spacecraft).

Two concepts of cluster systems of sliding composition are obvious. The first is based on the use of "rings" of cluster groups in several orbits of similar altitudes, which are located within an abstract tubular zone that encompasses them. The zone precesses together with the orbits; the longitude of the ascending node is corrected only to maintain the orbits within the precessing tube. Due to the uncorrectable divergence of satellites in orbits of different altitudes, spacecraft periodically move from cluster to cluster. A satellite system can be built on a set of rings of interacting clusters (both of the same type and differing in the "altitude" and "inclination" of the tubular zone of the ring). The second concept assumes several symmetric orbital groups of different altitudes with global coverage. The mismatches in the relative position of the satellites due to different orbit inclinations and altitudes are not corrected, and the spacecraft are moving from cluster to cluster. A special case of the concepts is clusters of permanent composition. Orbital grouping of the system can combine subgroups based on the first and second concepts. A number of algorithms were proposed for determining the current affiliation of a spacecraft to a cluster group. The aspect of creating a single communication network that unites many interacting clusters is highlighted. Approaches to the topology and load control of interacting cluster systems are proposed. The approaches are based on the distinguishing of intracluster and network-wide loads, and division of each type of load into priorities. Then the intracluster load can be routed through the nearest clusters with a change in its priority in them. When managing the load, two approaches can be combined: 1) a network node is one spacecraft; 2) a cluster group of spacecraft is considered as an abstract complex network node.