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# Ballistic problems in the synthesis of orbital segment of satellite information system based on small and micro spacecraft

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*The article presents an analytical review of the major ballistic problems in the synthesis of orbital segment of satellite information provision system based on small spacecraft. Much attention is paid to developing the concept of evaluating the possibility of universalization of small spacecraft satellite system for various purposes. On the basis of considering the problem statement of the synthesis of a ballistic satellite system structure as a Pareto-optimal system, it is shown that the small spacecraft system integration is possible primarily within one class of satellite systems or only "related" satellite system classes. Taking into consideration the trends in the development of classic heavy samples of space technology in civilian and dual-purpose systems, the requirements to technology precision of ballistic-navigation support for satellite system of spacecraft (including small spacecraft) for various purposes are formulated. The problems of using inter-satellite navigation and ballistic aspects of the implementation of the inter-satellite measurement technologies are discussed. The transition from heavy spacecraft systems to small spacecraft satellite system requires solving totality of innovative problems associated with both the construction of the individual satellites, and with adaptive restructuring ballistic-navigation support and its systems.*

**Keywords:** *satellite system, information provision, small spacecraft, orbital segment synthesis, satellite system structure, system-ballistic characteristics, ballistic-navigation support, inter-satellite navigation measurements, local group (cluster), innovative technologies.*

## REFERENCES

- [1] Astashenkov A. Sputnika pogrom [Satellite Defeat]. *Russkaya planeta – The Russian Planet*. Available at: <http://rusplt.ru/world/roi-sputnikov.html> (accessed 20.05.2013).
  - [2] Malye sputniki GKNTs im. M.V. Khrunicheva [Small Satellites of Khrunichev State Research and Production Space Center]. *Tele-Sputnik*, 2004, no. 12(110).
  - [3] Efremov G.A., Viter V.V., Lipatov A.A. Malye sputniki v setyakh svyazi i vesshchaniya [Small Satellites in Communication and Broadcasting Networks]. *Tekhnologii i sredsya svyazi — Technologies and Means of Communication*, 2000, no. 1, pp. 3–6.
  - [4] Gershenson V., Karpenko S. *Malye sputniki — provokatsiya ili perspektivnoe napravlenie?* [Small Satellites — a Provocation or an Upcoming Trend?]. Available at: <http://sk.ru/news/b/press/archive/2012/01/12> (accessed 12.01.2012).
  - [5] Psakhye S. Rossiyskie uchenye namereny sozdat gruppirovki "umnykh" minisputnikov [Russian Scientists Intend to Create a Group of "Smart" Small Satellites]. *Rianovosti – RIA News*. Available at: <http://ria.ru> (accessed 12.01.2012).
  - [6] Falichev O. Neulovimye nabludateli (malye kosmicheskie apparaty sposobny na bolshee) [Elusive Observers (Small Spacecraft Are not Doing Themselves
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- Justice)]. *Voenno-promyshlenny kuryer –Military-Industrial Messenger*, 2015, no. 28 (594), p. 8.
- [7] Fateev V.F., ed. *Malye kosmicheskie apparaty [Small Spacecrafts]. Izvestiya vuzov. Seriya Priborostroenie — Proceedings of Universities. Instrument Engineering*, 2009, vol. 52, no. 4.
- [8] Vlasov S.A., Mamon P.A. *Teoriya poleta kosmicheskikh apparatov [The Theory of the Spacecraft Flight]*. St. Petersburg, Mozhaisky Military Space Academy Publ., 2007.
- [9] Ivanov N.M., Lysenko L.N. *Ballistika i navigatsiya kosmicheskikh apparatov [Spacecraft Ballistics and Navigation]*. 2<sup>nd</sup> ed. Moscow, Drofa Publ., 2004.
- [10] Lysenko L.N., Razumnyy Yu.N. *Proektnaya ballistika sputnikovoykh sistem: sostoyanie i perspektivy [Design Ballistics of Satellite Systems: State of the Art and Prospects]. Conference “Ballistics Yesterday, Today and Tomorrow”. Collection of reports*. St. Petersburg, Mozhaisky Military Space Academy Publ., 2006, pp. 98–110.
- [11] Zabokritskiy A.V., Pasyukov V.V., Ponomarev S.A. *Tekhnologii navigatsionno-ballisticheskogo obespecheniya poletov kosmicheskikh sredstv [Technologies of Navigation-Ballistic Support of Spacecraft Flights]. Conference “Ballistics Yesterday, Today and Tomorrow”. Collection of reports*. St. Petersburg, Mozhaisky Military Space Academy Publ., 2006, pp. 82–97.
- [12] Lysenko L.N., Pankratov I.A. *Osnovy sputnikovoy navigatsii [Fundamentals of Satellite Navigation]*. Moscow, Voenizdat Publ., 1988.
- [13] Mozhayev G.V. *Sintez orbitalnykh struktur sputnikovoykh sistem. Teoretiko-gruppovoy podkhod [Synthesis of the Orbital Satellite System Structures. The group-theoretic approach]*. Moscow, Mashinostroenie Publ., 1989.
- [14] Gritsenko A.A. *Ispolzovanie stabilizirovannykh vrashcheniem malykh kosmicheskikh apparatov v sistemakh sputnikovoy svyazi na GEO i HEO orbitakh [Using Stabilized Rotation of Small Satellites in the Satellite Communication Systems for GEO and HEO Orbits]. IEEE*, 2001, no. 21, pp. 3–6.

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