The GLONASS orbit constellation architecture, which provides global fulfillment of promising requirements by the average value of the spatial geometric factor

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The purpose of the research was to compare the options for improving the GLONASS orbital constellation architecture by completing the standard orbital constellation with a high-orbit space complex of six satellites in elliptical geosynchronous orbits and by modifying the orbital constellation placing the GLONASS satellites in additional or existing orbital planes. The study shows that the option of adding a high-orbit space complex to the GLONASS system is difficult to implement due to the use of a different type of orbit and ensures that the requirements of the Federal Target Program "Maintaining, developing and using the GLONASS system for 2012–2020" are met according to the average spatial geometric factor of not more than 1.85 only in the Russian Federation. The least costly and satisfying these requirements for high latitudes (more than 49°) and in the entire range of longitudes is the addition of 6 satellites (two to each of the existing planes) to the standard GLONASS orbital constellation, the phase shift between all satellites being redistributed. For normal observation conditions, adding to each of the existing planes of four GLONASS satellites with a redistribution of the phase shift between them will globally ensure the spatial geometric factor of not more than 1.75 and the maximum, compared to the other options considered, availability of the navigation field in difficult observation conditions.

Keywords: *GLONASS, spatial geometric factor, navigation satellite, elliptic orbit, orbital plane, availability of the navigation field, elevation angle*

REFERENCES

[1] Solov'ev Yu.A. *Sputnikovaya navigatsiya i ee prilozheniya* [Satellite navigation and its applications]. Moscow, Eko-Trendz Publ., 2003, 326 p.

[2] Krasil'nikov A.N. *Novosti kosmonavtiki (Cosmonautics news)*, 2017, no. 11 (418), vol. 27, pp. 33–35.

[3] Braginets V.F., Mescheryakov V.M., Sukhoy Yu.G.. *Kosmonavtika i raketostroenie — Cosmonautics and Rocket Engineering*, 2017, no. 1 (94), pp. 95–102.

[4] Solov'ev Yu.A., Tsarev A.V., Korovin A.V., Ustyuzhanin D.A. *Novosti navigatsii (Navigation news)*, 2009, no. 2, pp. 25–33.

[5] Ignatovich E.I., Serdyukov A.I., Balashova N.N., Sintsova L.N., Zolkin I.A., Bolkunov A.I. *Obshcherossiyskiy nauchno-tekhnicheskiy zhurnal "Polet" — All-Russian Scientific-Technical Journal "Polyot" ("Flight")*, 2014, no. 1, pp. 20–29.

[6] Gritsenko A.A., Yur'ev R.N. *Infosfera (Infosphere)*, 2015, no. 66, pp. 9–12.

[7] Anpilogov V.R. *Tekhnologii i sredstva svyazi. Spets. vypusk "Sputnikovaya sviaz i veshchanie — 2014" (Technology and communications. Spec. no. "Satellite Communications and Broadcasting — 2014")*, 2013, no. 6 (2), pp. 24–31.

[8] Shalaginov A.A. *Tekhnologii i sredstva svyazi. Spets. vypusk "Sputnikovaya sviaz i veshchanie — 2014" (Technology and communications. Spec. no. "Satellite Communications and Broadcasting — 2014")*, 2013, no. 6 (2), pp. 16–17.

[9] Stepanov A.A., Akimov A.A., Gritsenko A.A., Chazov V.V. *Tekhnologii i sredstva svyazi. Spets. vypusk "Sputnikovaya sviaz i veshchanie — 2016" (Technology and communications. Spec. no. "Satellite Communications and Broadcasting — 2016")*, 2016, pp. 72–86.

[10] Kamnev E.F., Abolits A.A., Akimov A.A., Belov A.S., Bobkov V.Yu., Pelekhaty M.I. *Sistemy sputnikovoy svyazi s ellipticheskimi orbitami, razneseniem vetvey i adaptivnoy obrabotkoy* [Satellite communication systems with elliptic orbits, branch spacing and adaptive processing]. Moscow, Globsatkom Publ., 2009, 723 p.

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