Future GNSS Constellation Design Considering Compatibility and Interoperability

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ABSTRACT

To design a future GNSS constellation which can not only provides perfect navigation performance but also achieves compatibility and interoperability with other GNSS constellations, a systematic approach based on GNSS compatibility and interoperability is proposed. Firstly, in order to choose the optimal constellation parameters, three criteria which include the constellation positioning performance, geometry repeatability and stability are taken into account and evaluated. Secondly, four optimal compatible GNSS constellations are presented based on compatibility. Finally, two optimal compatible and interoperable GNSS constellations are presented through analyzing the constellation positioning performance and global satellites visibility. The systematic approach and the analysis results can provide the beneficial reference for future GNSS constellation design.

INTRODUCTION

With EU’s final approval to the European satellite navigation system Galileo, three autonomous GNSS systems would be available for many user communities in the near future. Meanwhile, China will start developing its own independent global navigation system. Japan and India are developing its regional sat-nav system.

The definition and implementation of future GNSS constellation have to take compatibility and interoperability issues into account. Compatibility refers to the assurance that one GNSS will ‘do no harm’ by degrading the stand alone services of another GNSS. Interoperability refers to the ability for the combined use of two or more satellite navigation systems to improve upon the navigation performance provided using only a single system.

It is to be noted that GNSS constellation compatibility must ensure that the constellation has been designed and optimized to fulfill navigation and positioning requirements firstly. This paper analyses only MEO constellation and selects Walker-type constellation. A Walker constellation is defined by there parameters $T/P/F$, $T$ is the total number of satellites, $P$ is the number of orbit planes, $F$ is the relative phase spacing between the satellites in adjacent orbit planes[1]. The main design parameters in GNSS constellation are the Walker parameters $(T/P/F)$, the orbital inclination, the semi-major axis. In order to choose the optimal constellation parameters, three criteria are taken into account and evaluated which include the constellation positioning performance, geometry repeatability and stability[2,3].

After designing the optimal constellation parameters, we have got some candidate GNSS constellations which can provide perfect navigation performance independently. But they might interfere with other GNSS constellations. Based on the analysis results of GNSS constellation compatibility some compatible constellation parameters will be obtained.

On the basis of the compatible analysis results, we use the constellation positioning performance and the global satellites visibility to evaluate and analyze these GNSS constellations interoperability. After that, some optimal compatible and interoperable GNSS constellations are proposed.

CONCLUSION

REFERENCES