

Overview of the application of Beidou Navigation Satellite System in civil aviation

Xin Jin, Yuhang Yang, Huaicai Zhang

The second research institute of CAAC, Chengdu Sichuan 61000, China

Abstract

As one of the core constellations of the Global Navigation Satellite System (GNSS), the Beidou Navigation Satellite System (BDS) is not only of great significance to ensuring China's national security, but also plays an immeasurable role in promoting China's all-round economic and social development. This paper introduces the navigation and monitoring application scenarios of the Beidou satellite navigation system in the field of civil aviation points out the relevant problems facing the comprehensive application of Beidou system in civil aviation at present, and provides some references for promoting the application of Beidou in various scenarios of civil aviation.

Keywords

Beidou; civil aviation; navigation; GBAS; SBAS; ADS-B.

1. Introduction

The Beidou Navigation Satellite System (BDS) is a satellite navigation system independently built and operated by China to meet the needs of national security and economic and social development. It is an important national space infrastructure and provides all-weather, all-day, and high-precision positioning, navigation, and timing services to global users.

2. Application of PBN operation

The PBN (Performance -based Navigation), which consists of the navigation facility, navigation specification, and navigation application, is regarded as the main development direction of global Navigation technology in the future, which is agreed by the International Civil Aviation Organization (ICAO)

ICAO defines three types of different enhancement systems to enhance satellite navigation performance. They include a Ground Based Augmentation System (GBAS), a Satellite Based Augmentation System (SBAS), and an ABAS Aircraft Based Augmentation System (ABAS). At present, the supporting enhancement systems for The Beidou navigation satellite system in the field of civil aviation in China are mainly based on the Beidou /GPS dual-mode ground-based enhancement system (GBAS) and The Beidou satellite-based enhancement System (BDSBAS).

2.1 SBAS

SBAS (Satellite-based augmentation system) is one of the important components of GNSS, which is increasingly showing its importance. It has become the standard configuration of all global systems. It can meet the navigation requirements of all stages from route and terminal area to class-I of precision approach (CAT-I). Navigation satellites are monitored by a large number of widely distributed monitoring stations, and geostationary satellites (GEO) issue correction information and integrity information to users. It consists of three parts: space segment, ground segment and user segment. It can provide economical and efficient navigation services for transportation and general aviation operation.

2.2 GBAS

The GBAS (Ground-Based Augmentation System) is a satellite navigation augmentation system with navigation augmentation information from ground transmitters, including space navigation satellite constellation system, ground augmentation system and airborne receiver.

Currently, CAAC is mainly promoting CATII/III GBAS, which requires the research on the precise approach guidance system compatible with GPS, Galileo and BDS. Breakthrough multi-system/multi-mode enhancement key technologies to improve integrity, continuity and usability indicators.

3. Application of ADS-B operation

ADS-B (Automatic Dependent Surveillance-Broadcast) technology is an aircraft operation monitoring technology based on global Satellite Navigation and Communication system (GSAT) that is being vigorously promoted by ICAO. At present, both the domestic and foreign aircraft are equipped with ADS-B, whose GPS location information are mostly from the United States, its access and accuracy are limited by the United States. The using of the BDS/GPS dual-mode combined navigation and separate BDS navigation, not only can eliminate the potential threats, but also the joint location accuracy than GPS single positioning nearly 40%, stability is superior to the latter, even if there is no GPS signal, which also can achieve accuracy of GPS and its stability more navigation, greatly enhance the our country civil aviation security.

4. Application of communication and surveillance

Relying on the Tiantong satellite mobile communication system and Beidou RDSS global short message communication network foundation, with the aid of aviation operations and ATC level information service center IT network architecture, application of cloud computing, GIS, achieve the goal of civil aviation aircraft in the world at any time, anywhere without blind area of message communication and location reports, and civil aviation passenger plane application oriented real-time position and posture monitoring, aircraft supporting command scheduling, emergency communications and situational Shared between aircraft.

5. Conclusion

At present, the application of Beidou in civil aviation is progressing steadily and some achievements have been made. However, there are still some problems to be solved if Beidou is to be fully applied in the field of civil aviation.

5.1 Domestic industrial capacity needs to be improved

The application of Beidou civil aviation cannot be separated from the technical and product support of the domestic industry. However, the domestic industry is not familiar with the airworthiness certification specifications and procedures of the airborne equipment of civil Aviation Administration at present and is afraid of difficulties. Therefore, the domestic industry should step up its efforts to go global and further strengthen its discourse power in the international civil aviation industry.

5.2 Insufficient satellite navigation signal monitoring capability

Current based on GPS satellite navigation operation has been widely used in the industry, however, because of a lack of independent satellite navigation performance monitoring network, the current airlines needed to run the satellite reliability still mainly provided by the foreign information, the current is still unable to effectively implement monitoring for domestic satellite navigation signal, make the PBN, ADS-B, GLS, etc. Based on the operation of the satellite navigation is still risky. It is the premise and foundation of ensuring the safe operation of China's air traffic that an independent and perfect satellite navigation ground monitoring network should be established to monitor the signal performance of Beidou, GPS and related enhancement systems, and to timely and effectively identify satellite faults, signal interference and the influence caused by space ionospheric activities.

5.3 The problem of location information transmission mode needs to be solved urgently

As is known to all, since the MH370 incident, global flight tracking technology has attracted extensive attention from the civil aviation industry of various countries. The technical key of global flight tracking is not positioning and navigation, but transmitting airborne positioning information to the operation control center through communication link. Currently, there are three solutions:

First, by combining Beidou positioning with RDSS communication, the application cost is relatively low. The technology is completely autonomous and controllable. The disadvantage is that the communication function only covers China and surrounding areas, and the communication quality, communication capacity and the number of terminals are limited. Therefore, this scheme is generally applicable to general aviation tracking and monitoring in the short term.

Second, the Beidou positioning information is transmitted down through international mainstream communication satellites (such as Iridium satellite and Inmarsat) by combining Beidou positioning with international communication satellites. The advantage is that the communication link is relatively mature and can cover the whole world. Beidou can be applied after realizing global open service. The disadvantage is that the communication link is controlled by others and the application cost is high. Iridium satellite and RDSS frequency conflict, difficult to coordinate.

Third, Beidou positioning is combined with autonomous communication satellite. The advantage of transmitting Beidou positioning information through self-built communication satellite is that the technology is completely autonomous and controllable. However, the construction period of China's communication satellite is relatively long, and orbital resources are difficult to coordinate. In the long run, the key to solve this problem is to build up China's space communication satellite network as soon as possible.

References

- [1] Shao Bo, Geng Yong-chao, Ding Qun, Wu Xian-bing. Review of International Satellite-based Enhancement Systems [A].*Modern Navigation*, 1674-7976- (2017) 03-157-05.
- [2] Zhang Peng, LIU Yi, Duan Zhao-bin. Research on ADS-B Signal Source based on BDS/GPS [A].*Measurement and Control Technology*, 1000-8829 (2015) 01-0012-04.
- [3] He Yun-cheng. Application status and development prospect of Beidou System in China's civil Aviation field.*Satellite Applications*, No. 9, 2019.
- [4] Liu Jin-yu. Application of Ground-based Reinforcement system in Civil Aviation. *China Science and Technology Information*, 2019, 7th Issue.
- [5] Wang Qiu-ping. ADS-B Technology based on Global Navigation Satellite System [A].*Science and Technology Consulting*, 1627-379 (2018) 09(b)-0058-03.