International Civil Aviation Organization

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Agenda Item 7: Navigation

7.4 Other navigation-related matters

APPLICATION OF LDACS IN AVIATION NAVIGATION NETWORK

(Presented by China)

SUMMARY

This information paper proposes an operational concept for applying LDACS in aviation navigation network. Utilizing LDACS broadband communication capabilities to mitigate threats of ionospheric anomalies and satellite navigation signal interference faced by GNSS/GBAS. By establishing a two-way air-ground data link, the concept enables bidirectional information sharing between airborne and ground systems, thereby supporting air-ground collaborative ionospheric threat refined modeling and wide-area interference monitoring and positioning.

1. INTRODUCTION

1.1 With the global deployment and application of the Ground Based Augmentation System (GBAS), satellite navigation signal interference and ionospheric anomalies are the main threats affecting its safe and efficient operation. GBAS ground stations use Very High Frequency (VHF) Data Broadcast (VDB) to transmit integrity augmentation information, but the VDB link has limited bandwidth and lacks a downlink from aircraft to ground, making it difficult to meet the data transmission requirements for integrity monitoring in anomalous environments.

1.2 CNS/ATM Laboratory of CAAC is actively developing an aviation navigation network operational concept and system based on the L-band Digital Aeronautical Communication System (LDACS). This system utilizes LDACS high-bandwidth characteristics to achieve downlink sharing of airborne navigation information and efficient transmission of ground navigation augmentation information, building an aviation navigation network through two-way air-ground data links, providing an effective means to address ionospheric threat and satellite navigation signal interference issues.

1.3 This paper introduces the operational concept of an aviation navigation network with LDACS communication capabilities at its core, including the aviation navigation network architecture, air-ground collaborative ionospheric threat refined modelling, and wide-area interference monitoring and positioning, discussing the role of combining GBAS and LDACS in enhancing aviation navigation service performance and reliability.

2. DISCUSSION

Aviation Navigation Network System Architecture

2.1 The aviation navigation network consists of three parts: space segment, airborne segment, and ground segment. The space segment includes satellite navigation constellations such as GPS, BDS, Galileo, and GLONASS; the airborne segment includes satellite navigation receivers, LDACS communication navigation terminals, and other airborne navigation sources; the ground segment includes GBAS ground stations, LDACS ground stations, and ground information processing centers.

2.2 With LDACS communication capabilities at its core, the network builds a two-way broadband air-ground data link between aircraft and ground, enabling downlink transmission of airborne navigation monitoring data and uplink broadcasting of augmentation information generated by the ground after comprehensive processing of multiple aircraft monitoring data. This two-way link breaks through the limitations of traditional GBAS VDB one-way communication, transforming airborne equipment from merely receiving integrity augmentation information to dynamic monitoring nodes in the aviation navigation network.

2.3 At the same time, utilizing LDACS's own navigation and positioning functions as an auxiliary navigation source further enhances system robustness, providing backup navigation capability when GNSS signals are interfered with or GBAS service is degraded.

Air-Ground Collaborative Ionospheric Threat Refined Modeling

2.4 Through LDACS broadband communication capabilities, the aviation navigation network builds an "air-ground collaborative" ionospheric anomaly monitoring network in the vicinity of airports, combining GBAS ground static ionospheric monitoring with airborne dynamic monitoring to form high-resolution perception capabilities of ionospheric conditions within the local range around the airport.

2.5 Aircraft equipped with LDACS equipment are transformed into mobile airborne sensors, collecting ionospheric monitoring data in real-time and transmitting it to the ground processing center via LDACS; the ground processing center collects and analyzes airborne data transmitted from aircraft in the regional range over a long period, extracting ionospheric variation characteristics to construct an ionospheric threat model tailored to local ionospheric features.

2.6 Compared to the current GBAS ionospheric threat model which uses wide-area monitoring data for conservative modeling, this air-ground collaborative regional and refined ionospheric threat model is expected to more accurately reflect the ionospheric conditions at the local airport, effectively reducing the overly conservative nature of existing models in regions with calm ionospheric activity, thereby helping to improve GBAS availability.

Wide-Area Interference Monitoring and Positioning

2.7 Similar to the current method of using ADS-B for satellite navigation signal interference monitoring and positioning, the aviation navigation network fully leverages LDACS broadband communication advantages to build a GNSS interference monitoring and positioning system covering the entire airspace.

2.8 Unlike the ADS-B method which can only transmit simple positioning status information, LDACS can simultaneously transmit more interference characteristic data monitored by the airborne GNSS receiver. At the same time, by fully utilizing the time and space coverage of multiple flights, the system comprehensively processes interference characteristic information and monitoring data collected by different aircraft at different times in a wide area to construct a more accurate interference signal propagation model, thereby achieving high-precision estimation of interference source locations, which is expected to enhance the effectiveness of interference monitoring and positioning.

3. **ACTION BY THE MEETING**

a) The meeting is invited to note the contents of this paper and discuss any issues as appropriate.

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