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ASSEMBLY — 38TH SESSION

TECHNICAL COMMISSION

Agenda Item 33: Air Navigation — Standardization

STATUS AND DEVELOPMENTS OF CHINA'S BEIDOU NAVIGATION SATELLITE SYSTEM (BDS)

(Presented by China)

EXECUTIVE SUMMARY	
This document describes the latest developments of China's BeiDou Navigation Satellite System(BDS), outlines China's principles of BDS application and prospects thereof, recounts advances in the relevant applications and implementation of the resolutions of the 37th Session of ICAO Assembly, and supports ICAO's call for a united approach to actively developing multi-constellation GNSS application protocols in light of future multi-frequency, multi-constellation GNSS applications, in order to meet the future needs of civil aviation and raise the level of safety and efficiency of the global air navigation system.	
Strategic Objectives:	This working paper relates to the Safety and Environmental Protection and Sustainable Development of Air Transport Strategic Objectives.
Financial implications:	Not applicable.
References:	Doc 9849, *Global Navigation Satellite Systems Manual*

1. INTRODUCTION

1.1 At present, Global Navigation Satellite Systems (GNSS) have become the bedrock of ICAO's air navigation services systems, and have been in extensive use in the field of civil aviation. The positioning, navigation and timing (PNT) services that such systems provide are the core technological means for ICAO's ASBU program. Protocols and standards by which GNSS provides services, as well as compatibility and interoperability thereof against interference are therefore issues of common concern to both ICAO and aviation users.

[1] Chinese version provided by the People's Republic of China.

1.2 BDS is a global navigation satellite system built and operated by China. Its open PNT services will be provided free of charge to all users, including aviation users, the world over. At the 37th Session of ICAO Assembly held in 2010, BDS was accepted as a member of ICAO GNSS systems. Work is underway to develop SARPs-related technical documents.

1.3 China's BeiDou System has successfully completed its second step of construction and now formally provides services on a regional scale. Systemic tests show that the system is performing well. Efforts are being made to coordinate with all concerned parties to ensure that the future BDS system is compatible and interoperable with other navigation satellite systems in a bid to form a worldwide navigation satellite development pattern where resources are shared and strengths complemented. As planned, a fully developed constellation with global coverage will be deployed in 2020.

2. AN OVERVIEW OF BDS DEVELOPMENTS AND APPLICATIONS

2.1 Development Goals

BDS is designed to provide continuous, stable and reliable satellite navigation services to users across the globe and cooperate with the planet's other navigation satellite systems to serve the world and benefit mankind.

2.2 Basic Principles

Openness：high quality services will be provided free of charge to users and all users of the world are welcome to use the system.

Self-reliance：China will rely on itself in independently developing and running the BDS system.

Compatibility：efforts will be made to achieve compatibility and interoperability with other navigation satellite systems so that users can use interoperable signals for better services.

Progression：In view of the potential technical and economic risks, development of BDS will follow a gradual and progressive process compatible with China's technological and economic realities.

2.3 System Components

BDS is composed of a space segment, a ground control segment and a user segment, of which, the space segment constellation consists of 5 GEO satellites and 30 Non-GEO satellites; the ground control segment includes over 30 ground stations such as main control stations, feeder stations and monitoring stations; and the user segment consists of the BeiDou user terminals and terminals to interoperate with other navigation systems.

The BDS system provides four types of services: authorized, open, wide area differential and short message communication services, with positioning accuracy better than 10 meters; timing accuracy better than 20 nanoseconds and velocity accuracy 0.2 meters/second.

2.4 Development Steps

Implementation of the system will follow a step-by-step approach based on the overall thinking and a master plan of “three steps” and “going regional first and then global”.

Step 1: initiation of the building of an experimental system in 1994 and formation of pilot regional services capabilities by 2000;

Step 2: initiation of the building of BDS in 2004 and formation of regional services capabilities by 2012;

Step 3: continuation of BDS development in 2013 and formation of global services capabilities by 2020.

2.5 Basic Policies

2.5.1 BDS provides free services to users across the globe, carries out on-going maintenance and improvements, and continuously raises the level of performance.

2.5.2 Formulate satellite navigation application policies and planning, promote a national system of standards and intellectual property projects, create new models of services, and facilitate growth of the satellite navigation industry in the country’s overall new system of modern industrial development.

2.5.3 Expand international applications based on the faith of development, cooperation and win-for-all in order to achieve compatibility and interoperability between BDS and other GNSS systems to advance the common interest of mankind.

2.6 Latest progress and capabilities

2.6.1 Building of the system

2.6.1.1 Completion of second-step networking

In 2012, “4 carrier rockets/6 satellites” were launched. It was the first time that China launched two navigation satellites with one rocket. 4 MEO satellites entered the scheduled orbit through two launches. Following its overall development scenario of “going regional first and then global”, China has in a span of eight years successfully completed the second of all three steps in its GNSS construction plan, thus opening up a path of its own for the development of satellite navigation capabilities.

At present, there are 14 working satellites in orbit, including 5 GEO satellites, 5 IGSO satellites and 4 MEO satellites，forming a constellation structured as “5GEO+5IGSO+4MEO”.

2.6.1.2 **Systemic tests**

Systemic tests have been carried out on a continuous basis. More than 40 entities, including the Ministry of Communications and Transport, China Meteorological Administration, China Southern Electric Grid, Wuhan University and research institutions like the Timing Center of the Chinese Academy of Sciences all participated in the trial tests. Vehicle-born, ship-born, aircraft-born and satellite-born platforms and meteorological space balloons were used, involving over 30 static test points, over 10 dynamic test routes(around city and between cities), and more than 6000 terminals carrying out comprehensive tests on signal quality and accuracy in space and capabilities to provide positioning, velocity determination and timing services. The results show that the system has been running on a continuous and stable basis and its performance has met designed target.

2.6.1.3 **The system now formally offers services**

On 27 December 2012, BDS formally began providing regional services. BDS Signal In Space Interface Control Document and the DBS Logo were issued.

In China and areas surrounding China, DBS service performance is as follows:

a) Service Area: 55 degrees south latitude to 55 degrees north latitude, longitude 55 degrees to 180 degrees east longitude;
b) positioning accuracy: 10 m plane，10 m elevation;
c) velocity accuracy: 0.2 m/second;
d) timing accuracy: unidirectional 50-nanosecond;

can provide two-way high-precision timing and short message communication services. Further performance improvements can be achieved by means of wide area differential and ground-based augmentation.

2.6.2 **Application developments**

BDS has already been successful in offering applications in the fields of transport, fishery, meteorological services and forestry. Current focuses are on enhanced planning and policy-making, R&D of basic and core products, industrial and regional demo applications, mass vehicle-born applications, emergency response applications, infrastructure construction and standardization.

2.6.3 In the field of civil aviation, CAAC has specified in the PBN implementation road map and ADS-B implementation plan that BDS will be used and is now planning for tests and assessments on DBS applications. For example, ADSB-2000A, an ADS-B equipment model manufactured in China, has received certification from CAAC. BDS applications are already in use in China-certified ADS-B products. BDS timing and positioning modules have been integrated into the Chinese-made ADSB-2000A receivers. Test results show that good results are achieved even when BDS alone is used to give time. It is also discovered that ADS-B receivers receive ADS-B position report earlier with DBS than with GPS.

2.6.4 **International cooperation**

2.6.4.1 Bilateral and multilateral cooperation

China, as a responsible member, has been deeply involved in all activities of the United Nations Office for Outer Space Affairs. As one of the four key GNSS suppliers, China successfully hosted the Seventh Session of the International Committee on Global Navigation Satellite Systems (ICG-7). More developing countries and emerging user countries participated in the meeting. For the first time, a Joint Declaration on Global Satellite Navigation System (GNSS) was issued, crystalizing the consensus that global navigation satellite systems are entering the stage of integration of multiple-system applications, and that all systems should further enhance cooperation amongst themselves in order to create a better life for mankind.

2.6.4.2 China has signed a business letter of intent with APSCO, and has been promoting cooperative projects with APSCO member states such as Thailand and Pakistan in the field of navigation satellite applications. China has also entered into talks with Russia, Indonesia and Pakistan on integrated applications between BDS and other systems.

2.6.5 **Promotion and initiative**

2.6.5.1 Great efforts have been made to launch the BeiDou/GNSS Application Demonstration & Experience Campaign (BADEC) in Pakistan and the Republic of Korea, where roadshows and exhibitions were held.

2.6.5.2 Continue in depth with the promotion of iGMAS and the issuance of monitoring and assessment parameters documents. Cooperation with Russia, Australia and Pakistan in the field of monitoring and assessment has been explored, and surveys and preparatory work for setting up overseas stations are underway, in order to facilitate the development of international GNSS monitoring and assessment services.

2.6.6 **Exchanges and training**

2.6.6.1 International academic exchanges are encouraged. Support is given to a CSNC-ION joint meeting at the annual China Satellite Navigation Conference, and to a BeiDou chapter at the annual US Institute of Navigation and the Munich Summit meetings.

2.6.6.2 Strengthen international academic training, establish a GNSS centre for international exchanges and training, prepare to set up the United Nations GNSS international centre for sciences, technologies and education, and conduct a United Nations navigation satellite master of sciences training program and summer courses of vanguard technologies.

2.6.7 **Positive response to ICAO A-37 resolutions**

2.6.7.1 In October 2011， at the invitation of ICAO, CAAC and China Navigation Satellite System Office participated in the ICAO meeting of introduction to global GNSS systems, and undertook to provide with BDS open, stable, continuous and free services to aviation users. With ICAO’s support, and based on ICAO Council decision to implement Resolution A37-12 on “developing SARPs to support China BDS’ entry into the global framework”, China has formally initiated work procedures for entry into the standardized framework of ICAO. With the assistance of ICAO NSP, China is now studying and

working on BDS technical documents for ICAO SARPs so as to lay the foundation for BDS services to international aviation users.

3. CONCLUSIONS

3.1 BDS has successfully completed its second step of development and has formally started providing regional services. BDS remains committed to providing free, stable and reliable positioning, navigation and timing services to its users.

3.2 BDS applications will be based on core technology breakthroughs, preceded by demonstration and driven by innovation, in order to vigorously promote development of the industry and industrial applications so that they will gradually enter into the lives of the board masses of the people.

3.3 BDS belongs to the world, as well as to China. We will actively promote the joint development of GNSS and the formation of a world navigation satellite development framework in which resources are shared and strengths are complimented.

3.4 China is committed to providing with its BDS continuous, open, safe and high quality PNT services while being cognisant of the challenges and problems that GNSS services face in terms of accuracy, integrity, continuity and availability. China supports ICAO's recommendation for use of a multi-constellation, multi-frequency GNSS system to reduce GNSS vulnerabilities. China will, within ICAO's operational framework, strengthen its BDS work on research and formulation of SARPs-related technical documents, conduct studies on the reduction of GNSS vulnerabilities and relevant multi-constellation, multi-frequency GNSS application issues, in order to facilitate interoperable applications between BDS and other navigation satellite systems, open up broader prospects for international cooperation and bring forward international monitoring and assessment, as well as work on multi-system applications.

3.5 The Assembly is invited to note the information presented in this paper.

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