China-Arab Joint BDS Test & Evaluation Results

Test and Assessment Research Center of China Satellite Navigation Office

Arab Information and Communication Technologies Organization

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Contents

1 Background

The China - Arab States BDS Cooperation Forum (CASBCF) was firstly proposed by Chinese President Xi Jinping during his speech at Headquarters of the League of Arab States on January 21st, 2016. Within the framework of CASCF, the CASBCF will provide a multilateral platform and a kind of long-term cooperation mechanism for international cooperation and exchanges in the field of satellite navigation. On July 10th, 2018, BDS/GNSS test and evaluation cooperation was written into the outcome document of the 8th Ministerial Conference of the China-Arab Cooperation Forum, the China-Arab Cooperation Forum Action Plan for 2018-2020, which was highly valued by the Secretariat of the League of Arab States and the Chinese Ministry of Foreign Affairs.

From January to March 2019, Test and Assessment Research Center of China Satellite Navigation Office (CSNO-TARC) and Arab Information and Communication Technologies Organization (AICTO) jointly carried out test and evaluation activities of BDS in the Arab region, including static testing and dynamics. The test covers the main areas of the Arab region. Two sides jointly completed the work of BDS testing and evaluation.

2 Test contents

2.1 Constellation status

Demonstrate the global average number of BDS visible satellites and PDOP values.

(1) Global average number of visible satellites

Statistics on the global average number of visible satellites within the specified time.

(2) Global average PDOP value

Statistics on the global average PDOP value within the specified time.

2.2 Open service performance

Verify the static and dynamic positioning performance of BDS. The assessment items are as follows:

(1) Positioning accuracy

Under the specified user conditions, the statistical value of differences between the positions determined by BDS signals and the high precision reference positions, including the horizontal positioning accuracy and the vertical positioning accuracy.

(2) PDOP availability

The percentage of time that the PDOP value meets its limit requirements in the specified service area, within the specified time, and under other specified conditions.

(3) Positioning service availability

The percentage of time required for the horizontal and vertical positioning errors to meet the accuracy criteria, in the specified service area, within the specified time, and under other specified conditions.

2.3 Test contents list

NO.	Classification	content	Test task
1.	Constellation status	Global average number of visible satellites	Static
2.		Global average PDOP value	Static
3.	Open service performance	Positioning accuracy	Static, dynamic
4.		PDOP availability	Static
5.		Positioning service availability	Static

3 Static testing

3.1 Testing stations distribution

Fig.1 Static testing stations distribution

For static testing, China-Arab BDS/GNSS Center station in Tunis (AICT), Benha University station in Egypt (BENH), Khartoum station in Sudan (SUDN), Algiers station in Algeria (ALGR) and Kuwait station provided testing data.

3.2 Testing conditions

3.2.1 AICT station

Based on the China-Arab BDS/GNSS Center station in Tunis, the observation data of the BDS was collected. The observation time was 2019-03-14 0:00-22:00 (UTC) for a total of 22 hours. The data collecting device is NET20 PLUS receiver from Beijing UniStrong Science & Technology Co., Ltd..

Fig.2 AICT station data collecting device

3.2.2 ALGR station

Based on the iGMAS Algeria station, the observation data of the BDS was collected. The observation time was 2019-01-01 0:00-24:00 (UTC), in total 24 hours. The data collecting device is iGMAS CETC receiver.

Fig.3 ALGR station data collecting device

3.2.3 BENH station

Based on Benha University Station in Egypt, the observation data of the BDS was collected. The observation time was 2019-03-19 6:00-15:00 (UTC) for a total of 9 hours. The data collecting device is T300 receiver from ComNav Technology Ltd..

Fig.4 BENH station data collecting device

3.2.4 SUDN station

Based on Khartoum station in Sudan, the observation data of the BDS was collected. The observation time was 2019-03-14 8:00-2019-03-15 8:00 (UTC) for a total of 24 hours. The data collecting device is T300 receiver from ComNav Technology Ltd..

Fig.5 SUDN station data collecting device

3.2.5 KUWT station

Based on Kuwait station, the observation data of the BDS was collected. The observation time was 2019-03-23 12:00 - 2019-03-24 12:00（UTC） for a total of 24 hours. The data collecting device is T300 receiver from ComNav Technology Ltd..

Fig.6 KUWT station data collecting device

3.3 Testing results

3.3.1 Constellation Status

Based on iGMAS stations' observation data, from Feb.22nd to Feb.28th, in total 7 days' average number of visible satellites and the average PDOP value have been analyzed. Results show that:

(1) Global average number of visible satellites

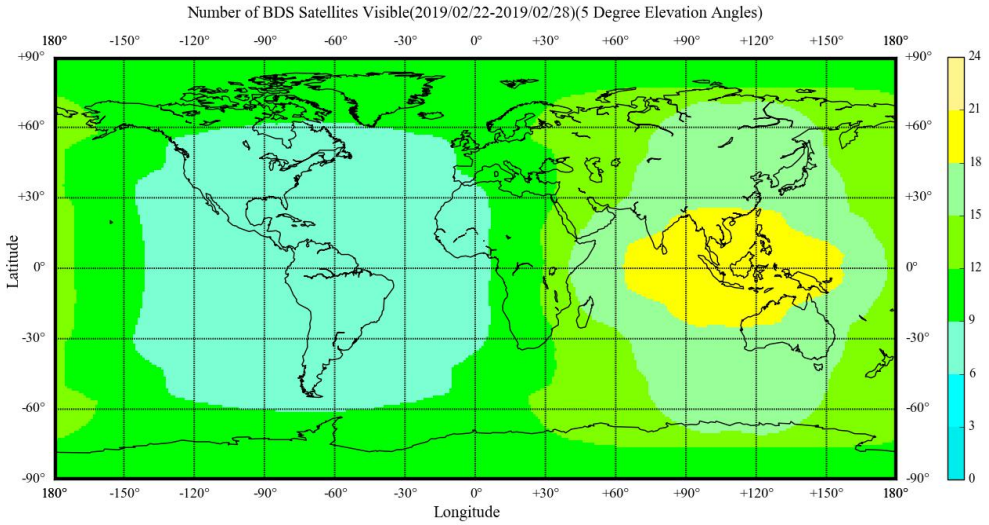

Fig.7 The Distribution of Average Number of Visible Satellites

(2) Global average PDOP value

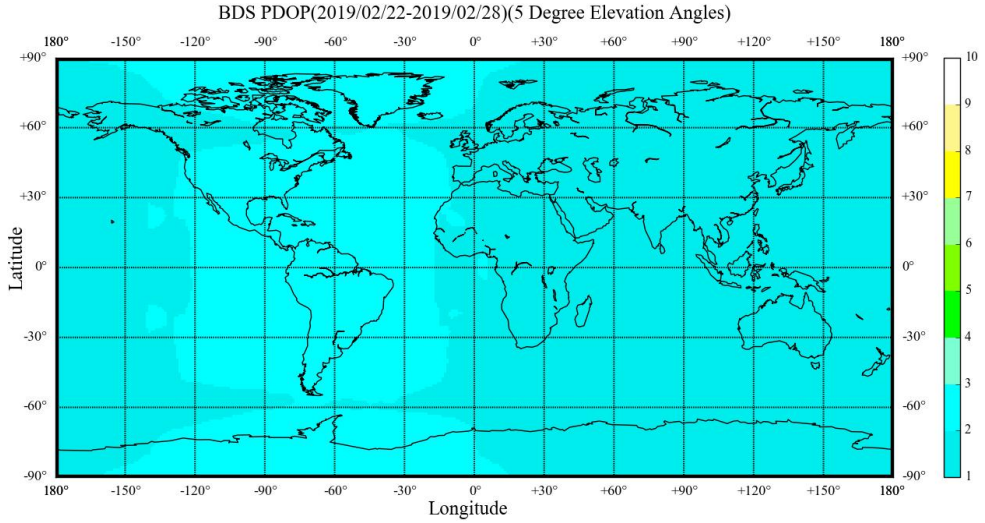

Fig.8 The Distribution of Average PDOP Value

From Fig.7&8, the global average number of visible satellites≥6. In Arab region, the number is more than 8. The global average PDOP value <4. Therefore, BDS could well cover Arab region with advantageous constellation.

3.3.2 Open service performance

(1) Positioning accuracy

Table 1 Positioning Accuracy Statistics（PDOP≤6，unit: m，95%）

NO.	Station Name	B1I		B3I		B1C		B2a	
		H	V	H	V	H	V	H	V
1.	AICT	2.01	3.37	3.11	5.62	-	-	-	-
2.	ALGR	2.06	3.84	2.12	4.52	2.04	4.05	3.32	6.52
3.	BENH	3.76	5.01	4.34	8.12	-	-	-	-
4.	SUDN	3.81	5.26	4.65	9.03	-	-	-	-
5.	KUWT	2.94	5.73	2.89	7.34	2.74	5.85	3.53	7.35

(2) PDOP availability

Table 2 BDS PDOP Availability

Frequency	PDOP Availability（Average，PDOP≤6）
B1I/B3I	99.63%
B1C/B2a	93.26%

(3) Positioning service availability

Table 3 BDS Positioning Service Availability

NO.	Station Name	B1I	B3I	B1C	B2a
		H≤20m V≤20m	H≤20m V≤20m	H≤20m V≤20m	H≤20m V≤20m
1.	AICT	100%	99.6%	-	-
2.	ALGR	99.2%	99.0%	96.1%	94.3%
3.	BENH	98.9%	98.5%	-	-
4.	SUDN	97.6%	96.5%	-	-
5.	KUWT	100%	100%	97.1%	96.7%

From Table 1,2&3, BDS pseudorange positioning accuracy at each frequency is better than 10m. B1I/B3I PDOP availability reaches 99.63%, B1C/B2a PDOP availability reaches 93.26%. B1I/B3I positioning service availability is better than 95%，B1C/B2a positioning service availability is better than 94%.

4 Dynamic Testing

4.1 Testing Conditions

4.1.1 Khartoum, Sudan

The vehicle-based dynamic testing was conducted along the AIWadi Highway in the north part of Khartoum, in total about 50km. The observation period was from 2019-03-14 T10:00 (UTC) to 2019-03-14 T12:00 (UTC)， in total 2 hours. T300 GNSS Receiver from ComNav Technology Ltd. was selected for data observation.

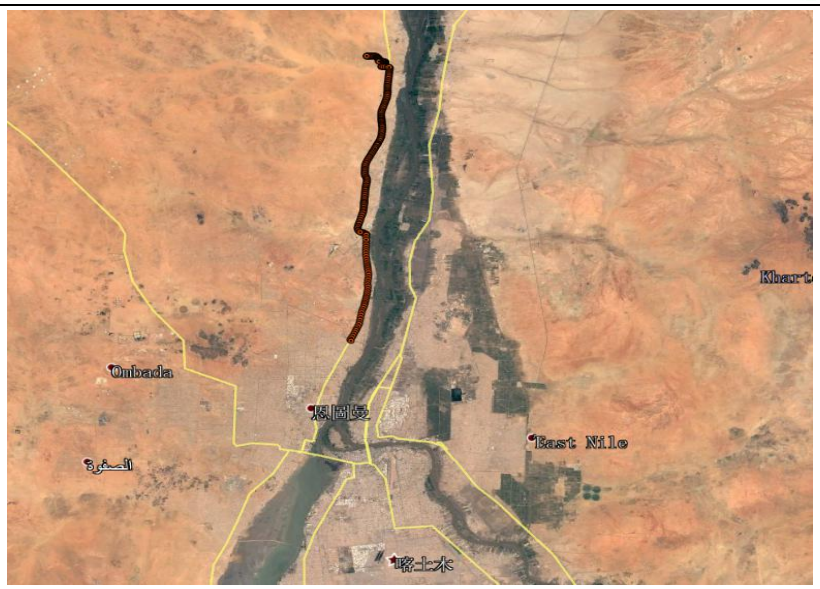

Fig.9 Testing Route in Khartoum, Sudan

4.1.2 Cairo, Egypt

From Benha University, the dynamic vehicle-based testing was conducted along Cairo Regional Ring Rd, in total about 70km. The observation period was from 2019-03-19 T7:00 (UTC) to 2019-03-19 T9:00 (UTC)， in total 2 hours. T300 GNSS Receiver from ComNav Technology Ltd. was selected for data observation.

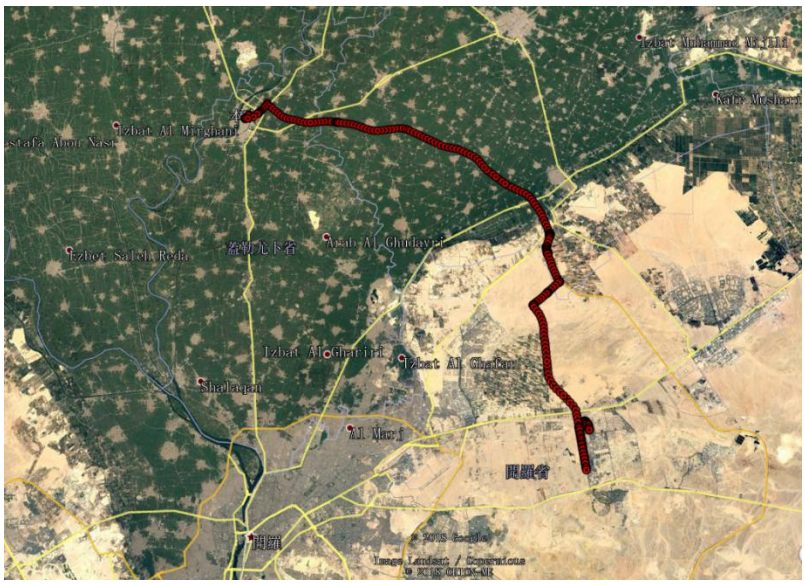

Fig.10 Testing Route in Cairo, Egypt

4.2 Testing Results

The BDS dynamic positioning accuracy at different signal frequencies were tested. Results are listed as follows:

Table 4 Positioning Accuracy Statistics（PDOP≤6，unit: m，95%）

NO.	Location	B1I		B3I	
		H	V	H	V
1.	Cairo	5.23	7.26	6.85	9.21
2.	Khartoum	4.81	5.26	6.09	9.35

From Table 4, BDS B1I&B3I dynamic pseudorange positioning accuracy is better than 10m.

5 Summarization

From January to March 2019, China-Arab Joint BDS Test & Evaluation activities were conducted within the above five testing regions and periods. Results show that:

(1) The global average number of visible satellites ≥ 6. In Arab region, the number is more than 8.The global average PDOP value <4.

(2) BDS single frequency pseudorange positioning accuracy in static test: AICT station is better than 3.11m (horizontal), 5.62m (Vertical). ALGR station is better than 3.32m (horizontal), 6.52m (Vertical). BENH station is better than 4.34m (horizontal), 8.12m (Vertical). SUDN station is better than 4.65m (horizontal), 9.03m (Vertical). KUWT station is better than 3.53m (horizontal), 7.35m (Vertical). BDS single frequency pseudorange positioning accuracy in dynamic test: Cairo (Egypt) is better than 6.85m (Horizontal), 9.21m (Vertical). Khartoum (Sudan) is better than 6.09m (Horizontal), 9.35m (Vertical).

(3) B1I/B3I PDOP availability reaches 99.63%， B1C/B2a PDOP availability reaches 93.26%. B1I&B3I single frequency positioning service availability is better than 95%. B1C&B2a single frequency positioning service availability is better than

94%.

From results, each BDS service performance index satisfies the requirements in 《BeiDou Navigation Satellite System Open Service Performance Standard (Version 2.0)》 in the above tests. BDS could provide continuous and steady positioning and navigation services in the Arab region.