Using BeiDou System for precise positioning in Europe

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Currently BeiDou System is the fastest developing navigation system. At present number of BDS satellites may allow to use that system for precise positioning in Europe. The aim of this test was to try to obtain precise position in Olsztyn in Poland using BDS.
BeiDou System is a Chinese navigation system whose full operability is foreseen for 2020. On December 27 2012 the full functionality over the area of Asia was announced. Full constellation will consist of:

- 5 Geostationary satellites GEO – orbits height 35 786 km;
- 3 Geosynchronous Satellites IGSO – orbits height 35 786 km, inclination 55º;
- 27 Medium Earth Orbit satellites MEO – orbits height 21 528 km, inclination 55º.

In 2015 the modernization of BDS system began.

Currently following satellites are providing navigational signals:

- 5 Geostationary Satellites GEO;
- 6 Geosynchronous Satellites IGSO;
- 3 Medium Earth Orbit satellites MEO.

There are also:

- 1 Geostationary Satellites GEO;
- 2 Geosynchronous Satellites IGSO (third generation satellites);
- 3 Medium Earth Orbit satellites MEO (third generation satellites);

Not used in this test.
BeiDou system use the following frequencies:\[1\]:

- **B1** = 1561.098 MHz, from third generation **1575.42 MHz** (shared with GPS L1 and Galileo E1);

- **B2** = 1207.140 MHz, from third generation **1191.795 MHz** (B2a = 1176.45 MHz shared with GPS L5 and Galileo E5a, B2b = 1207.14 MHz shared with Galileo E5b);

- **B3** = 1268.520 MHz.

\[1\] Source: Mingquan Lu, Zheng Yao, New Signal Structures For BeiDou Navigation Satellite System, 2014
BeiDou System constellation
Test were carried out on data from August 17 2016.

3h observation session (18:00-21:00 UTC) with 5 seconds interval was used.

Data come from two stations in Olsztyn, KRO1 (reference station) and OPNT (rover).

Baseline length: about 4300 m.

MAFA method was used.

Single-epoch positioning was used.

(The Modified Ambiguity Function Approach (MAFA) is a method of GNSS carrier phase data processing. In this method, the integer nature of the ambiguities is taken into account in the functional model of the adjustment).
Skyplot

GPS

BDS

- PRN 1
- PRN 2
- PRN 3
- PRN 4
- PRN 5
- PRN 6
- PRN 7
- PRN 8
- PRN 9
- PRN 10
- PRN 11
- PRN 12
- PRN 13
- PRN 14
- PRN 15
- PRN 16
- PRN 17
- PRN 18
- PRN 19
- PRN 20
- PRN 21
- PRN 22
- PRN 23
- PRN 24
- PRN 25
- PRN 26
- PRN 27
- PRN 28
- PRN 29
- PRN 30
- PRN 31
- PRN 32

- GEO PRN 2
- GEO PRN 5
- IGSO PRN 7
- IGSO PRN 9
- IGSO PRN 10
- MEO PRN 11
- MEO PRN 12
- MEO PRN 14
DGNSS Results

**GPS**

- **dN [m]** vs **dE [m]**
- Data points clustered around the center

**BDS**

- **dN [m]** vs **dE [m]**
- Data points scattered more widely

Both graphs show the distribution of data points in a squared area, with GPS showing a tighter clustering and BDS showing a more dispersed distribution.
Precise positioning Results
dE and dN

**GPS**

**BDS**
Precise positioning Results
dU
### Results

<table>
<thead>
<tr>
<th></th>
<th>GPS</th>
<th>BDS</th>
<th>DGNSS</th>
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<tbody>
<tr>
<td></td>
<td>dN</td>
<td>dE</td>
<td>dU</td>
</tr>
<tr>
<td><strong>DGNSS</strong></td>
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<tr>
<td>dN</td>
<td>0,15</td>
<td>0,38</td>
<td>1,19</td>
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<tr>
<td>dE</td>
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<tr>
<td>dU</td>
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<td>0,56</td>
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<table>
<thead>
<tr>
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<th>Precise positioning</th>
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<tbody>
<tr>
<td></td>
<td>dN</td>
</tr>
<tr>
<td><strong>Correct</strong></td>
<td>-0,004</td>
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<tr>
<td><strong>Incorrect</strong></td>
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<tr>
<td><strong>Correct</strong></td>
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<tr>
<td><strong>Incorrect</strong></td>
<td>0,156</td>
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<table>
<thead>
<tr>
<th>Solutions</th>
<th>Correct</th>
<th>Incorrect</th>
<th>Correct</th>
<th>Incorrect</th>
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<td></td>
<td>2007</td>
<td>153</td>
<td>752</td>
<td>1408</td>
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<td></td>
<td>93%</td>
<td>7%</td>
<td>35%</td>
<td>65%</td>
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</table>
In Central Europe, it is possible to obtain precise position using only BeiDou System. However, it is possible only in short period of time.

The number of obtained correct solutions and precision are still low.

PDOP factor for BDS is still high in Europe.

However still increasing number of satellites give us a hope that in short period of time it will be possible to use BDS for precise positioning not only in short periods of time.
Thank you for your attention!

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