GALILEO
HIGH ACCURACY SERVICE DAYS
Galileo HAS performance

Madrid / Galileo High Accuracy Service Days / 28–29/07/2023
Agenda

- service documents
- performance targets
- HAS results vs. minimum performance levels
- HAS results vs. user performance metrics
- examples illustrating HAS benefits
service documents
Service Documents

GALILEO HIGH ACCURACY SERVICE DEFINITION DOCUMENT (HAS SDD)
Issued 1.0
January 2023

GALILEO HIGH ACCURACY SERVICE INTERNET DATA DISTRIBUTION INTERFACE CONTROL DOCUMENT (HAS IDD ICD)
Issued 1.0
January 2023

GALILEO HIGH ACCURACY SERVICE SIGNAL-IN-SPACE INTERFACE CONTROL DOCUMENT (HAS SIS ICD)
Issued 1.0, May 2022

Registration required!

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performance targets
HAS provides corrections for...

- E1, E5a, E5b, E6
- L1 C/A, L2C
What are we looking at …

… in terms of performance?
HAS results vs. minimum performance levels
“[…] over the instantaneous constellation average (computed as Root Mean Square)”
“[…] over the instantaneous constellation average (computed as Root Mean Square)”
Accuracy – code bias corrections

“[...] over the instantaneous constellation average (computed as Root Mean Square)”
Availability – HAS corrections

Galileo only modes

Galileo + GPS modes
Availability – monitoring station network

- SIS monitoring
- IDD monitoring
- Performance > Target
Availability – volume analysis (SIS)

Galileo ≥ 5 SVs
MPL = 87%

Galileo + GPS ≥ 8 SVs
MPL = 95%

February 2023
March 2023
April 2023
Availability – volume analysis (IDD)

Galileo ≥ 5 SVs
MPL = 87%

Galileo + GPS ≥ 8 SVs
MPL = 95%

February 2023

March 2023

April 2023
HAS results vs. user performance metrics
HAS performs good! (I)

HAS user terminal at EUSPA Headquarter – 68%, 24 hours (sliding window) – Galileo E1/E5a + GPS L1/L2C

<table>
<thead>
<tr>
<th>Month</th>
<th>Horizontal Positioning Error, in m</th>
<th>Vertical Positioning Error, in m</th>
</tr>
</thead>
<tbody>
<tr>
<td>February 2023</td>
<td>0.15 - 0.50</td>
<td>0.20 - 0.50</td>
</tr>
<tr>
<td>March 2023</td>
<td>0.15 - 0.50</td>
<td>0.20 - 0.50</td>
</tr>
<tr>
<td>April 2023</td>
<td>0.15 - 0.50</td>
<td>0.20 - 0.50</td>
</tr>
</tbody>
</table>
HAS performs good! (II)

HAS user terminal at EUSPA Headquarter – SPP (Galileo + GPS) vs. HAS (Galileo + GPS) – single epoch results

- February 2023
- March 2023
- April 2023

Horizontal positioning error, in m
Vertical positioning error, in m
HAS performs good! (III)

HAS user terminal at EUSPA Headquarter – SPP (Galileo + GPS) vs. HAS (Galileo + GPS) – single epoch results

February 2023
March 2023
April 2023
¡THANK YOU!

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The Galileo HAS Service Definition document (SDD) describes elements of primary interest for the HAS user:

- description and target values for committed HAS performance figures;
- typical HAS performance metrics.

According to the actual Initial Service provision phase, HAS delivers corrections aimed to improve the following magnitudes computed by a user receiver:

- reconstruction of spacecraft payload coordinates in Earth Centred, Earth Fixed axes;
- estimates of satellite clock offset with respect to the reference GNSS time;
- estimates of Observable Specific Biases affecting code range measurements.

By means of such corrections and a proper algorithm, the receiver can achieve a Precise Point Positioning (PPP) solution, without the need of any further aid.

Note: HAS delivers corrections in the Service area, for both “Galileo only” and Galileo + GPS navigation solution.
HAS Service area is GLOBAL, while excluding regions identified in the figure above:

- defined by Latitudes [60ºS – 60ºN] and Longitudes [90ºE – 180ºE]
- defined by Latitudes [60ºS – 60ºN] and Longitudes [125ºW – 180ºW]

Any HAS user within the excluded regions may still use the Galileo HAS corrections, but the committed targets for the Minimum Performance levels (MPLs) ONLY apply to the Service area.
# Details on Committed Accuracy

<table>
<thead>
<tr>
<th>FIGURE OF MERIT</th>
<th>MPL TARGET</th>
<th>CONDITIONS AND CONSTRAINTS</th>
</tr>
</thead>
</table>
| HAS orbit corrections      | • ≤ 20 cm (95%) for Galileo  
• ≤ 33 cm (95%) for GPS  
over the instantaneous constellation average (computed as RMS) | • Calculated over a period of 30 days  
• All HAS-corrected and valid Galileo/GPS satellites in view from any point in the Service area |
| accuracy                  |                                                                                |                                                                                           |
| HAS clock corrections      | • ≤ 12 cm (95%) for Galileo  
• ≤ 15 cm (95%) for GPS  
over the instantaneous constellation average (computed as the RMS) |                                                                                           |
| accuracy                  |                                                                                |                                                                                           |
| HAS code biases            | • ≤ 50 cm (95%) for both Galileo and GPS  
over the instantaneous constellation average (computed as RMS) |                                                                                           |
| accuracy                  |                                                                                |                                                                                           |
## Details on Committed Availability

<table>
<thead>
<tr>
<th>FIGURE OF MERIT</th>
<th>MPL TARGET</th>
<th>CONDITIONS AND CONSTRAINTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>HAS corrections availability</td>
<td>• ≥ 87% Galileo-only</td>
<td>• 5 degrees elevation mask</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Calculated over a period of 30 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• At least 5 HAS-corrected and valid satellites in view</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• At the Worst User Location (WUL) of the Service area</td>
</tr>
<tr>
<td></td>
<td>• ≥ 95% Galileo + GPS</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• 5 degrees elevation mask</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Calculated over a period of 30 days</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• At least 8 HAS-corrected and valid satellites in view</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• At the WUL of the Service area</td>
</tr>
</tbody>
</table>
## Details on Typical Performance – Positioning Accuracy (Galileo only)

<table>
<thead>
<tr>
<th>FIGURE OF MERIT</th>
<th>TYPICAL PERFORMANCE</th>
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<tbody>
<tr>
<td>HAS horizontal positioning</td>
<td>• ≤ 25 cm Galileo only</td>
<td>• 68th percentile confidence level</td>
</tr>
<tr>
<td>accuracy</td>
<td></td>
<td>• Over any 24 hours period</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• For the signal combinations supported by the HAS</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Using the HAS performance characterisation user algorithm (HAS-UA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• At least 5 HAS-corrected and valid satellites in view above 5 degrees elevation under open sky conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Static user</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Applying orbit and clock corrections and code biases for the involved signals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• At the Average User Location (AUL) of the Service area</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Usage assumptions as per HAS-SDD</td>
</tr>
<tr>
<td>HAS vertical positioning</td>
<td>• ≤ 30 cm Galileo only</td>
<td></td>
</tr>
<tr>
<td>accuracy</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Details on Typical Performance – Positioning Accuracy (Galileo + GPS)

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<tr>
<td>HAS horizontal positioning accuracy</td>
<td>• ≤ 15 cm</td>
<td>• 68th percentile confidence level</td>
</tr>
<tr>
<td></td>
<td>for Galileo + GPS</td>
<td>• Over any 24 hours period</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• For the signal combinations supported by the HAS</td>
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<td>• Using the HAS performance characterisation user algorithm (HAS-UA)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• At least 8 satellites in view above 5 degrees elevation for Galileo + GPS users under open sky conditions</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Static user</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Applying orbit and clock corrections and code biases for the involved signals</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• At the Average User Location (AUL) of the Service area</td>
</tr>
<tr>
<td></td>
<td>• ≤ 20 cm</td>
<td>• Usage assumptions as per HAS-SDD</td>
</tr>
<tr>
<td></td>
<td>for Galileo + GPS</td>
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# Details on Typical Performance – Positioning Availability

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</table>
| HAS positioning availability | ≥ 90 %              | • Fulfilling both horizontal and vertical positioning accuracy targets as per HAS-SDD  
• Calculated over a period of 30 days  
• For the signal combinations supported by HAS  
• Using the HAS performance characterisation user algorithm (HAS-UA)  
• Under open sky conditions  
• At least 5 HAS-corrected and valid satellites in view above 5 degrees elevation for Galileo-only users  
• At least 8 HAS-corrected and valid satellites in view above 5 degrees elevation for Galileo + GPS users  
• Static user  
• Applying orbit and clock corrections and code biases for the involved signals  
• At the Average User Location (AUL) of the Service area  
• Usage assumptions as per HAS-SDD |