Status of ESA’s independent Earth Orientation Parameter product

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Outline

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- Motivation for an ESA’s independent EOP product
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Introduction

• The availability of highly accurate, up-to-date Earth Orientation Parameters (EOP) is of major importance for all positioning and navigation applications on Earth, Sea, Air and also in Space.
• Today, the EOP predictions are generated by a single non-European actor, provided on a non-European server.
• Over the past years, ESA repeatedly experienced problems with outdated or missing predictions of the Earth Orientation Parameters (Bulletin A).
• Considering the importance of up-to-date Earth orientation parameters, the dependence on a single source outside Europe is considered as a risk for European industry, for ESA missions and EU programmes.
ESA’s contributions to International Services provided by ESOC

- Contribution to **International GNSS Service (IGS)** as Analysis Centre
- Contribution to **International Laser Ranging Service (ILRS)** as Analysis Centre
- Contribution to **International DORIS Service (IDS)** as Analysis Centre
- Contribution to **International VLBI Service (IVS)** as Analysis Centre planned
- Contribution to **Coordinated Universal Time (UTC)**
ESA’s IGS contribution/EOP’s (REPRO2) provided by ESOC

### WRMS of EOP residual time series

<table>
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<tr>
<th></th>
<th>XPO μas</th>
<th>YPO μas</th>
<th>XPOR μas/d</th>
<th>YPOR μas/d</th>
<th>LOD μs/d</th>
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<td>16.4</td>
<td>62.7</td>
<td>70.1</td>
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</tr>
</tbody>
</table>
ESA’s IGS contribution/length of day (REPRO2) provided by ESOC

**AC / ig2 LOD differences**

**Normalized periodograms**

ESA EOP/LOD Quality amongst the best in the IGS
ESA’s ILRS contribution provided by ESOC

ESA’s ILRS solution amongst the best
ESA’s IDS contribution provided by ESOC

On the left are shown the Helmert parameters from the first ESA ITRF2020 test solution over the ITRF2014 period (comparison to the IDS ITRF2014 cumulative solution). First combination of this solution with the other ACs show that the ESA solution is the closest to the new combination solution. The ESA solution is still evolving and several improvements are planned before the final submission planned for early 2021.
ESA’s internal VLBI solution provided by ESOC

The plots compare two VLBI realizations of the EOP time series with the IERS C04 solution. ESA estimates are plotted in colour, while the grey dots represent the results provided by an official IVS AC (artificial offsets applied). The scatter of the two datasets is comparable and there are no significant spurious signals affecting the long-term behaviour.
Motivation for an ESA’s independent EOP product

ESA’s Navigation Support Office is responsible for providing the Geodetic reference for ESA missions, and acts as Coordinator of the Galileo Reference Service Provider (GRSP) to provide the Geodetic reference and corresponding EOP’s to Galileo.

### ESA operates Ground Infrastructure
- **ESA’S GNSS Observation Network (EGON)**
- ESA/Europe is building up SLR stations
- European Space Tracking network (ESTRACK)
  Note: Stations and correlator are not yet ready for VLBI

### ESA operates Data Centres
- **Gnss Science Support Centre (GSSC)**

### ESA generates all input products needed for the generation of EOPs.
ESA’s contributions are always among the best in the world.

### European Independence
Although all required input products are generated by ESA, ESA and its customers are still relying on a single, non-EU entity to provide EOPs.
Objective:
Prototype development of an independent ESA Earth Orientation Parameter product, providing the best possible accuracy and precision for real-time and post-processing applications.

Consortium:

Completion: Mid-2020
IERS state of the art combination approach

Products
- IGS contributions
- ILRS contributions
- IDS contributions
- IVS contributions

Combination on Parameter level
- ERP
- ERP
- ERP
- ERP

Earth Orientation Parameter

Limitations: Model inconsistencies, Correlations not considered!
ESA approach

Products

- ESA IGS contribution
- ESA ILRS contribution
- ESA IDS contribution
- ESA internal VLBI solution

Combination on Normal Equation level

- NEQ
- NEQ
- NEQ

Earth Orientation Parameter

Same software and models. Correlations considered.
ESA approach

Products

- ESA IGS contribution
- ESA Special SLR solution
- ESA IDS contribution
- ESA internal VLBI solution

Combination on Normal Equation level

- NEQ
- NEQ
- NEQ
- NEQ

Earth Orientation Parameter

ESA ILRS solution replaced by optimised SLR solution e.g. adding Larets, Stella, Starlette, and Ajisai
ESA target approach

Combination on observation level

- ESA IGS contribution
- ESA ILRS contribution
- ESA IDS contribution
- ESA internal VLBI solution

Rigorous combination on observation level.
Preliminary results from ESA-EOP study

$\Delta UT1$ predictions accuracy

Preliminary results from the ESA study “Independent generation of Earth Orientation Parameters” showed that the predictions already outperformed the up-to-date Bulletin A
Way forward for ESA’s independent EOP product

Available for all ESA space missions, Europe’s Space program and European industry

End of 2020

ESA internal VLBI solution

End of 2020

Operational provision of ESA’s independent EOP Solution

End 2021 (to be agreed)

ESA contribution to IVS
Takeaways

• Earth Orientation Parameters are critical for all Space Missions, positioning and navigation solutions.

• Up-to-date Europe is relying on a single non-European actor.

• ESA’s Navigation Support Office is one of the main contributors to the International Services, generating the ITRF and the EOP’s.

• ESA’s Navigation Support Office will start providing an independent European Earth Orientation Parameter Prediction product by the end of 2020.
Europe’s independent Geodetic and EOP Reference

Navigation Support Office
ESA’s Navigation Supporter

Provider of ESA’s geodetic and timing reference
GRSP Coordinator (GTRF provider)
Contributor to IERS (ITRF, EOP)
Contributor to UTC

http://navigation-office.esa.int

GNSS Science Support Centre
ESA’s Galileo Navigation Science Office

IGS Global Data Centre
ILRS Data Provider
GNSS Science Exploitation Platform
GNSS Big Data Station

https://gssc.esa.int/

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