IGMA Progress and Plan

ICG WG-S, B, D joint session
IGMA TF
Satoshi Kogure, Shuli Song, Erik Schoenemann
2023-October-18
Current status of IGMA JTP

• Initial Joint Trial Project (JTP) is being implemented in collaboration with IGS.

• Four limited parameters were selected, and initial calculation results were reviewed.

• Findings suggested a need of common calculation methodologies before comparing among each participant’s calculation.

• General Principles for common calculation methodologies were clarified.

• Work continues on procedural steps for calculating the parameters for each system, and Datafile Specifications for results.
ToR revision status (1/2)

- **Major revised points**
  - ✓ Restructuring contents of Terms of Reference (ToR):
    - The Revised ToR limited to administrative and strategic items. Technical and mathematical details were described in the separate document, “ICG IGMA-IGS JTP Calculation Methodology”.
    - Annex III Roadmap for IGMA was removed and new document was created titled “Roadmap for IGMA-IGS Joint Trial Project”.
  - ✓ Adding NavIC to Joint Trial Project
  - ✓ Annex I definition of parameters were updated.
    - Mathematical expression in PDOP definition was deleted.
    - Single SIS URE definition was replaced with two precise definition.
  - ✓ Revising Annex IV – Milestones of Trial Project.
    - Latest milestones, i.e. “2nd calculation run” and methodologies and data format agreement, were described with target schedule
Structure change of IGMA JTP ToR

Main body

Annex I
Definition of parameters

Annex II
Methodology of monitored parameters

Annex III
Roadmap for IGMA

Annex IV
GNSS reference documents for observation/calculation of monitored parameters

Annex V
List of TF members, Participants and Point of Contact

Annex VI
Milestones of Trial Project

Annex VII
Change Record

Main body

Annex I
Definition of parameters

Separate document
“ICG IGMA-IGS JTP Calculation Methodology”

Separate document
“Roadmap for IGMA-IGS Joint Trial Project”

Annex II
Reference documents

Annex III
List of TF members, Participants and Point of Contact

Annex IV
Milestones of Trial Project

Annex V
Change Record
ToR revision status(2/2)

- **Line by Line review was conducted**
  - At IGMA Workshop in Rabat, Morocco August 29, 2023.
  - Some texts were amended in accordance with TF members’ suggestions and comments.
  - No substantial changes to the revised draft.
  - Review by providers done, no additional comments on it.
  - Ready for approval

- **Review by IGS and confirmation of participants**
  - Under review by IGS Monitoring WG until the end of October 2023.
  - The roster of current IGS participants in the JTP is being refreshed and updated.
  - IGS Monitoring WG chair will report the review results and confirmation of participants to IGS Governing Board in end November 2023.
Common methodologies (1/3)

✓ The Calculation Methodology document was agreed to be grouped by parameters instead of by GNSS systems and was reconstructed.

✓ The process for calculating orbital and clock errors was agreed to be described by separate sequences of calculation steps. The orbit error should be calculated first and then the clock error.

✓ First version of step-by-step calculation procedure for orbit and clock has been collected from GPS, GLONASS, Galileo, BDS and QZSS.

✓ It was agreed that URE will be assessed through two methods: “Calculated” and “Measured”. The “Calculated” method is chosen for the first stage of IGMA JTP.

✓ Common GNSS PDOP assessment method was agreed inside IGMA TF, including temporal-spatial resolution grid model, statistical methods, observation period, etc.
## Common PDOP Assessment Method

<table>
<thead>
<tr>
<th>Issue</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consider precision</td>
<td>Two decimal places</td>
</tr>
<tr>
<td>Evaluation metrics</td>
<td>Global average PDOP availability</td>
</tr>
<tr>
<td></td>
<td>Global 95&lt;sup&gt;th&lt;/sup&gt; percentile PDOP availability</td>
</tr>
<tr>
<td></td>
<td>Worst site PDOP availability</td>
</tr>
<tr>
<td>Grid model</td>
<td>GRID_EAL (Equal-Arc-Length Grid)</td>
</tr>
<tr>
<td>T-S (Temporal-Spatial) resolution</td>
<td>300 seconds – 3 degrees</td>
</tr>
<tr>
<td>Statistical method and period</td>
<td>Sliding window, ground track repeat period of each system</td>
</tr>
<tr>
<td>Assessment scope</td>
<td>Full latitude span for global systems</td>
</tr>
<tr>
<td></td>
<td>Partial span corresponding to coverage area for QZSS and NavIC</td>
</tr>
</tbody>
</table>

The grid generating code for GRID_EAL and grid file can be shared for all users.
Global PDOP availability in GRID_EAL (spatial resolution: 3°, temporal resolution: 300s, mask angle: 5°). (a) for GPS, (b) for BDS, (c) for GLONASS and (d) for Galileo. Doy 2021.251-2021.260.

Calculation efficiency and storage performance for BDS PDOP evaluation with different grid models and T-S resolution. The computer hardware is Intel(R) Core (TM) i9-9900 CPU @ 3.10GHz with 64GB RAM.
Next Steps

- ToR revision
  - Request approval from ICG (conditional)
    - After IGS review, if no substantial changes are proposed.
    - New recommendation?
- Complete description of step-by-step calculation methods for clock error, SIS-URE, and UTCOE.
- Finalize data exchange format
- 2nd calculation run in advance of the next workshop
- Prepare for next workshop in the first half of 2024
  - Candidate venues in Asian countries, Thailand or China
    - MGA conference 2024, end of January to beginning of February, Chiang Rai, Thailand
<table>
<thead>
<tr>
<th>Item</th>
<th>Status</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>IGMA Workshop 2015</td>
<td>Completed</td>
<td>Hosted by China in conjunction with CSNC in Xian (May 2015) The monitoring and assessment parameter sets were discussed.</td>
</tr>
<tr>
<td>Establish Joint Trial Project with IGS</td>
<td>Completed</td>
<td>IGS governing board approved proposal and created GNSS Monitoring WG in Dec 2016</td>
</tr>
<tr>
<td>IGMA and PS Workshop 2017</td>
<td>Completed</td>
<td>In Shanghai, hosted by China (SHAO) in 2017. Monitoring and assessment methodology, specification and Data Center for data/results sharing were discussed first time for IGMA.</td>
</tr>
<tr>
<td>IGMA and PS Workshop 2018</td>
<td>Completed</td>
<td>In Noordwijk, hosted by EU (GSA) in May 2018. Definition, Methodology, and data format were discussed.</td>
</tr>
<tr>
<td>IGMA and PS Workshop 2019</td>
<td>Completed</td>
<td>In Vienna, hosted by US in June 2019. The 1st Calculation results were exchanged.</td>
</tr>
<tr>
<td>Methodology harmonization</td>
<td>In progress</td>
<td>PDOP and orbit error: done SIS RE have almost done. Clock error and UTCOE need further input from providers &amp; IGS</td>
</tr>
<tr>
<td>Data exchange format harmonization</td>
<td>In progress</td>
<td>Proposed template format will be shared.</td>
</tr>
<tr>
<td>IGMA Joint Trial Project ToR revision</td>
<td>In progress</td>
<td>Line-by-line review has been done. Review in IGS Monitoring WG is on going.</td>
</tr>
<tr>
<td>Monitoring site specifications</td>
<td>In progress</td>
<td>Draft will be distributed in November teleconf.</td>
</tr>
<tr>
<td>2nd Calculation Run</td>
<td>Under discussion</td>
<td>Depending on the next workshop Calculation periods and parameters have been agreed</td>
</tr>
<tr>
<td>Planning the next IGMA and PS Workshop</td>
<td>Under discussion</td>
<td>In person Workshop is desired. To be discussed during ICG-17. First half of 2024 is a current target date, candidate locations are in Asian countries, Thailand or China</td>
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</table>
IGMA JTP Roadmap
Updated as of Oct. 2023

Short term goal: Proof of IGMA concept
- Four params (system level) for each single constellation
- Post processing
- Consistent output with harmonized methodologies

Results discussion and harmonization

Fixing issues from initial trial (Methodology harmonization)

Gathering data

Computation period selection

Output Data Formats

Calculation Methodology

Commitment letters (ICG Providers)

WS in Vienna June 2019

ICG-18 in 2024

WS in 2024 (TBC)

Providing report to ICG

Set additional params

ICG-15 in 2021

ICG-14 in 2019

ICG-15 in 2021

Computation period selection

2nd Attempt TP

Data exchange and provision issues

Feb and/or Apr 2019

Initial Trial Project

WS in Noordvijk May 2018

Stations list harmonization

MACs list harmonization

Done*

* Except for Japan and India
IGMA JTP Roadmap

Beyond 2024

Updated as of Oct 2023

Add new parameters
- User level parameters such as positioning, velocity, and timing accuracy.
- Combined solutions with multiple constellations

ICG-18 in 2024
Providing JTP first stage report to ICG

ICG-19 in 2025
- Harmonizing methodologies for new params
- Data set period set-up

ICG-20 in 2026
Providing JTP second stage report to ICG
- Harmonizing methodologies for real-time monitoring
- Data set period set-up

ICG-21 in 2027
- Harmonizing methodologies for real-time monitoring
- Data set period set-up

ICG-22 in 2028
Providing JTP third stage report to ICG

Long term goal:
- Proof of real-time performance monitoring and evaluation result dissemination