Expert Consultation meeting on Strengthening the Global Geodesy Supply Chain

22 – 23 April 2024

Conference Room LE 2312, 23rd Floor, Langer Eugen Building UN Campus,
Platz der Vereinten Nationen 1, 53113 Bonn, Germany

SUMMARY NOTES

Preamble

The Expert Consultation meeting on Strengthening the Global Geodesy Supply Chain was hosted by the United Nations Global Geodetic Centre of Excellence (UN-GGCE) at the United Nations Campus in Bonn from 22 to 23 April 2024. The meeting was attended by 46 representatives from 14 Member States from across four UN regions and included participants from international geodetic research institutions and relevant stakeholders.

This Expert Consultation meeting brought representatives from Member State civilian science, defense and policy agencies together to:

1. Introduce the Global Geodesy Supply Chain and explain why it is vital for national economies and the operation of critical infrastructure.
2. Discuss the weaknesses in the Global Geodesy Supply Chain and the threat to our use of space from a civilian and defense perspective.
3. Discuss pathways and actions to address weaknesses in the Global Geodesy Supply Chain in the short, medium and long-term.

Summary of the meeting

What is the Global Geodesy Supply Chain and what is our dependence on it?

Mr Nicholas Brown (Head of Office, UN-GGCE) introduced the topic and described the Global Geodesy Supply Chain (GGSC) as collection of ground station observatories, data centres, analysis centres and highly qualified people who create geodetic products and services, everyday, which are necessary for people and machines on Earth to accurately and reliably transmit and receive information between Earth and satellites.

Mr Brown highlighted that satellites are integral to our modern lives explaining that the U.S. Department of Homeland Security found that 15 of 18 critical infrastructure and key resources sectors relied on the Global Positioning System (GPS). Furthermore, Member States depend on satellite services for economic benefits. Over the next decade, revenue from Global Navigation Satellite Systems (GNSS), Earth Observation (EO) and satellite telecommunications is expected to grow at a mean annual growth rate of approximately 9%, reaching a total of almost €800 billion.

Ms Markiel (USA) then explained how GNSS is critical for accurate timing and positioning information crucial for various sectors including telecommunications, energy, financial systems, and emergency services. Key sectors such as stock exchanges, energy distribution, and telecommunications heavily rely on GNSS for time synchronization and data transmission. Ms Markiel outlined the need for

improved processes and governance to operationalize geodesy and relieve the pressure on the science community who are currently performing a great deal of the operational workload, but not being funded to do it.

Ms Markiel described the decline in teaching of geodesy in universities with the US only graduating 19 US citizens in geodesy in the past decade. Some Member States described a similar decline in student number and university courses. Ms Markiel explained that over the past five years, the GGSC has twice narrowly avoided the loss of major elements, and that it exhibits a fragile stability, which could easily collapse. Ms Markiel finished her introduction by appealing to Member States to fund the GGSC as National Critical Infrastructure.

Ms Megan Johnson (USA) and Mr Rüdiger Haas (Sweden) explained the essential role the Very Long Baseline Interferometry technique plays in the GGSC using distant quasars as navigational aides which allow scientists to measure the changes in the shape and orientation of the Earth. These bright spots in the sky are the foundation for all coordinate reference systems and the only way to align atomic time to celestial time.

The importance of the GGSC for science and society

Mr Richard Gross (USA), Mr Mark Greaves (UK) and Mr Mark Brammer (UK) presented to participants on the important role of the GGSC for science and society. Mr Gross highlighted the critical role of the GGSC to address and respond to some of the greatest challenges of our time including sea level rise, ice loss, water monitoring and natural hazards such as earthquakes, and tsunami. Mr Greaves and Mr Brammer described the process the UK government is currently going through to have elements of the GGSC recognized as Critical National Infrastructure (CNI). In particular, significant investments in the timing network are being made to ensure the UK are not completely dependent on GNSS as a timing source for CNI and key resource sectors.

Following this series of presentations Member States had an open discussion on the information presented and expressed their views and opinions. Mr Gross remarked that there are "… way too many single points of failure in the GGSC. One person goes on maternity leave and the EOP determination becomes corrupt. It needs to be more robust." Mr Chris Jacobs (USA) mentioned that we need evidence for policy makers on how we can make it more robust and how to quantify we have become more robust. Mr Brauer (Germany) expressed the need for a global effort with a clear need from Member States to support the UN-GGCE Joint Development Plan for Global Geodesy to convince politicians of the importance of geodesy and demonstrated the need to go to underrepresented areas and find ways to build infrastructure and operate in those regions.

The current status of the VLBI network

Mr Stephen Merkowitz (USA) presented on the current status of the VLBI network throughout the world. Mr Merkowitz described daily VLBI measurements as vital for determining and predicting the time-varying alignment of the Terrestrial Reference Frame with respect to the Celestial Reference Frame (using Earth Orientation Parameters). Mr Merkowitz explained that although there are approximately 50 VLBI stations around the world, the vast majority of the work is being done by 13 stations. Mr Merkowitz also noted that the lack of consistency in the hardware makes it difficult to maintain effective and efficient processes to maintain hardware, or find suppliers who can provide maintenance and repairs. On this topic, Ms Markiel explained that the lack of standardization across the GGSC (e.g. custom made bearings) leads to lack of efficiency, high costs and a lack of industrial workforce to support the geodetic community. Ms Markiel expressed that it could be more efficient if an improved governance structure could be provided to handle the operational aspects of the GGSC.

The current status of the Global Geodesy Supply Chain

Mr Zuheir Altamimi (France) presented on the current state of the GGSC. Mr Altamimi outlined that space geodesy is global science, and therefore the responsibility to operate sustainable infrastructure needs to be global. Nonetheless, the current input and effort from around the world is not global. Mr Altamimi described the International Terrestrial Reference Frame (ITRF) as an essential output of the GGSC and a critical piece requirement for satellite operations, noting that "every satellite needs to have its position well defined in ITRF". Mr Altamimi also highlighted a need for a better global distribution of ground stations. In particular, a need for increased stations in the southern hemisphere, remarking that the "current observations from ground stations in Australia are essential for the realization of accurate reference frames and for accurate and reliable orbit determination".

Spectrum management

Throughout the meeting there was a number of discussions on the topic of spectrum management with many Member States noting the challenges they face to identify and sustain ground stations sites which are free from optical or radio interference primarily due to growing populations. Member States broadly agreed on the need to have "quiet zones" and encouraged each other to consider establishing local rules / arrangements where existing ground stations are, and consider exploring options of using existing "quiet zones" to collocate ground stations. One such example of a local rule / arrangement was the case that Germany have been working on to have a "coordination zone" around the Wetzell Observatory for 5G. Ms Ashley Zauderer-VanderLey (USA) remarked that given one of the biggest threats to quiet zones are communication systems, and communication systems are dependent on geodesy. It could therefore be worth spending time talking with and educating this community who could ultimately become a strong advocate for geodesy.

The need to stabilize the Global Geodesy Supply Chain now

Ms Markiel expressed a need for Member States to coordinate and advance mutual efforts across national and international participant partners, now, to:

- stabilize the GGSC, with particular emphasis on the development of intergovernmental Member State commitments to support foundational Positioning, Navigation, and Timing (PNT);
- foster resiliency and integrity to existing GGSC to mitigate malign influence, including efforts to declare GGSC as Critical National Infrastructure (CNI) (US), or the equivalent of CNI (non-US);
- share GGSC data across the partners with integrity, with particular focus on mitigating cybersecurity concerns;
- develop and deliver the next generation GGSC;
- advance geodesy expertise; and
- work with the United Nations Global Geodetic Centre of Excellence (UN-GGCE) in Bonn to advance GGSC at the international level.

1st Joint Development Plan for Global Geodesy

Mr Brown described that the UN-GGCE have recently undertaken a global geodesy needs assessment to identify what is needed to strengthen the GGSC. Feedback from over 500 participants across 110 Member States indicates that effort is required across five focus areas of evidence, resources, governance, capacity and awareness. This information will be used to create the 1st Joint Development Plan for Global Geodesy (JDP).

Mr Brown outlined the structure of the JDP which will provide:

- a vision and plan for the future of the GGSC;
- a summary of the State Of Geodesy;
- strategic objectives and actions required to stabilize the current GGSC and enhance it for the future; and
- description of work packages which will need to be completed to in order to describe what a "fit for purpose" future state for the GGSC looks like.

During the open discussion on the JPD, Member State representatives expressed their views on the priorities to sustain the GGSC including:

- The over-reliance on academia which is particularly vulnerable when academia can't justify their role in geodesy. It was noted that this sometimes translates to their inability to justify their existence.
- A clear need for stronger operational support throughout the GGSC given that some critical infrastructure is operating on a "shoestring" budget.
- The challenges in translating the science into policy for impact.
- The need to have a consistent message throughout the academic, civilian and defense on what geodesy is and why it is critical.
- The opportunity to take advantage of Member State infrastructure initiatives and public private partnerships (PPP) to help with funding.
- The need for evidence to demonstrate the importance of: 1. Stabilizing the current GGSC to avoid further degradation; and 2. Establishing a more robust and operational GGSC in the future.
- Member States asked for information such as the impact of losing sites in their hemisphere, or their country, on national PNT applications. This is not currently well defined.
- Member States also wanted to know what contributions they could make to the GGSC to make the greatest contribution. This too is not currently well defined.
- The need for intergovernmental governance model which is run by Member States which does not disrupt the science governance model of the IAG to implement of the JDP.

Draft Decisions from the Expert Consultation meeting on Strengthening the Global Geodesy Supply Chain (22-23 April 2024)

a. Member States acknowledge the risks associated with failure, or degradation in the Global Geodesy Supply Chain (GGSC)[1].
b. Member States agree that they need to ensure we have a Celestial Reference Frame, Terrestrial Reference Frame, Earth Orientation Parameters and satellite orbit products which do not degrade from current levels, and prepare for advancement as needed to meet future scientific and operational requirements.
c. Member States resolve to coordinate and advance mutual efforts to work with the United Nations Global Geodetic Centre of Excellence (UN-GGCE) in Bonn to sustain and advance the GGSC. This could include items 1-6 below:
    1. Stabilize existing GGSC, with particular emphasis on the development of Member State commitments for GGSC to support foundational Positioning, Navigation, and Timing (PNT).
    2. Foster resiliency and integrity to existing GGSC to mitigate malign influence, including efforts to declare Member State contributions to the GGSC as Critical National Infrastructure (CNI) (US), or the equivalent of CNI (non-US).
    3. Openly share GGSC data with integrity, with particular focus on mitigating cybersecurity concerns.
    4. Develop, deliver and ensure sustainment of the next generation GGSC across the Member States.
    5. Advance geodesy expertise.
    6. Advocate for better awareness of the GGSC within, and across Member States, international forums and complementary organizations such as those engaged with spectrum management.
d. Member States agree to support the UN-GGCE staff in the creation of the "1st Joint Development Plan for Global Geodesy" by, where possible:
    1. reviewing drafts, consulting internally, and providing feedback to UN-GGCE staff; and
    2. providing in person or virtual secondments to the UN-GGCE.

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[1] The Global Geodesy Supply Chain includes:

- Geodetic observatories (e.g. Global Navigation Satellite Systems Continuously Operating Reference Stations (GNSS CORS), Very Long Baseline Interferometry (VLBI), Satellite Laser Ranging (SLR), Doppler Orbitography and Radiopositioning Integrated by Satellite (DORIS), gravimeters etc.)
- Data collection (e.g. international, regional and national data centres)
- Data analysis (e.g. international, regional and national analysis centres)
- Products (e.g. clock and orbit products, atmospheric models, Earth Orientation Parameters (needed by satellites to accurately observe and communication with applications on Earth)).
- Product transmission (e.g. real-time data streams)
- Frames of reference:
    - Terrestrial reference frame (e.g. realizations of the International Terrestrial Reference Frame)
    - Celestial reference frame (e.g. realizations of the International Celestial Reference Frame)
    - Gravity reference frame, height reference frame and geopotential model.
- Capacities and capabilities residing in Member States and organizations (like the services of the International Association of Geodesy) who perform the work in the Global Geodesy Supply Chain to analyse, compute, create and sustain the frames of reference.