United Nations

United Nations Global Geodetic Centre of Excellence

POLICY BRIEF NO001

Hidden Risk

How weaknesses in the global geodesy supply chain could have catastrophic impacts on critical infrastructure and national economies

INTRODUCTION

Modern society is dependent on satellites. In many countries, satellite information is essential for economic growth, the operation of critical infrastructure, and is a cornerstone of national defence forces.

In some cases, the dependence is so strong that countries have developed sovereign space systems. For example, several countries or regions, e.g., the European Union (EU), have their own Global Navigation Satellite System (GNSS) to provide Positioning, Navigation and Timing (PNT) services for civilian and defence applications including the Global Positioning System (GPS; USA), GLONASS (Russian Federation), Galileo (EU) and BeiDou (PRC). These countries recognize that a loss of PNT services, either due to technological failures or malicious activity, would have catastrophic and cascading effects for their economy and critical infrastructure. This reliance and need for control is not limited to GNSS satellites which provide PNT services, but extends to telecommunications satellites and Earth Observation (EO) satellites.

Observing the Earth

Satellites providing vital defence and civilian applications are reliant on constant updates about their 'place in space' (satellite orbit information) and the Earth's 'place in space' (shape, orientation, gravity field, and coordinate reference frame).

This Earth and satellite 'place in space' information are collectively known as geodetic products. Constant updates to the geodetic products are needed because the Earth and satellites are always moving. Without updates to geodetic products, satellite applications that society takes for granted, and all the benefits they provide would degrade or fail.

GLOBAL GEODESY SUPPLY CHAIN

The geodetic products are created through the global geodesy supply chain (Figure 1) which includes:

- ground observatories and scientists who constantly observe the movement of the Earth and satellites;
- data centres and data centre operators who quality check the data from observatories and make it available to the global geodesy analysis community; and,
- analysis centres, correlation centres and analysts who translate the raw data into geodetic products.

It is a *global* geodesy supply chain because the observatories and highly qualified people need to be distributed around the world to achieve the required accuracy and reliability of the geodetic products.

Recognizing the risk of a degrading supply chain, the United Nations General Assembly adopted resolution 69/266 in 2015, entitled 'A Global Geodetic Reference Frame for Sustainable Development'. The resolution encourages Member States to

Key Messages

- Society's dependence on satellite services for economic development, the operation of critical infrastructure, and defence applications is very high and growing at a rapid pace.
- Satellite services are at risk of degradation or failure due to the lack of resources provided to the global geodesy supply chain.
- For satellites to operate accurately and reliably, their 'place in space' and Earth's 'place in space' need to be observed and analyzed constantly. This information is provided through the global geodesy supply chain.
- The global geodesy supply chain is the collection of ground observing stations, data centres, analysis centres and highly qualified experts who observe the Earth and convert these observations into geodetic products which are essential to communicate accurately and reliably with satellites.
- Although the supply chain is a vital foundation of the space sector, it is relatively unknown and therefore under-resourced. Less than 0.05% of the revenue generated from GNSS and EO services are reinvested in the global geodesy supply chain.
- Member States and partners are forming a Joint Development Plan describing how they will work together to strengthen the supply chain to enhance the reliability and integrity of the geodetic products.
- Key activities for Member States include: strengthening national awareness and governance in geodesy, recognizing the global geodesy supply chain as national critical infrastructure and engaging in bilateral or multilateral agreements with other Member States.

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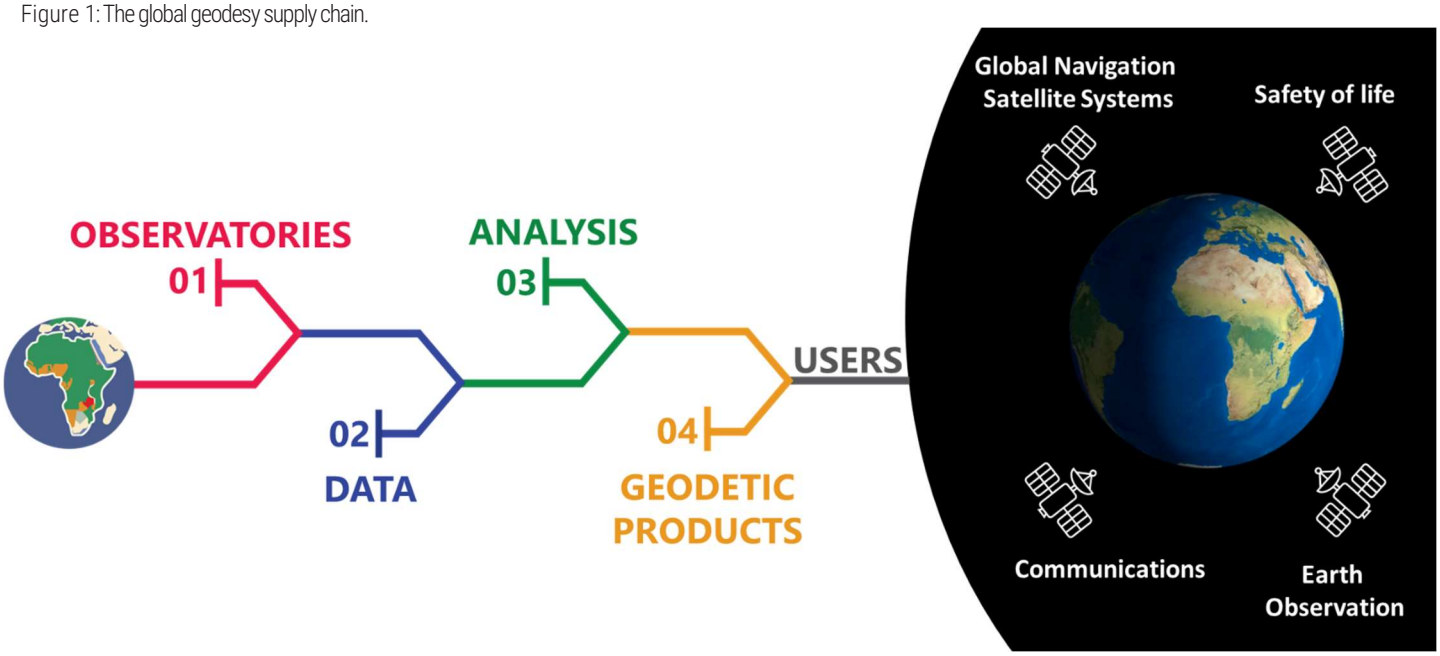
Figure 1: The global geodesy supply chain.



work together to sustain and enhance the global geodesy supply chain. Despite the adoption of the resolution, the risk associated with the degradation remains hidden to many.

THE GROWING RELIANCE ON GEODESY

Operation of critical infrastructure

Although best known as a positioning and navigation system, accurate on-board atomic clocks make GNSS satellites excellent timekeepers. As a global, 24/7 operational, free (to the user) resource, GNSS (predominantly GPS) has become the world's primary system for the distribution of accurate (sub-microsecond) time. However, this heavy reliance on GNSS timing raises concerns about potential weaknesses in the global geodesy supply chain.

The U.S. Department of Homeland Security found that 15 out of 18 critical infrastructure and key resources sectors relied on the GPS including telecommunications, emergency services and financial exchanges.

Without GNSS timing, the operation of mobile phone networks would be impossible, stock exchanges would have reduced protection for investors and, the daily operation of power grids would be more difficult and labour intensive.

Economic benefits

National economies are increasingly reliant on revenue generated from satellite services. Over the next decade, global GNSS downstream market revenue is expected to grow at a mean annual growth rate of 9.2%, reaching a total of €492 billion by 2031. Over 82% of the revenue will be generated in mass market user segments (e.g. mobile devices, tourism, health and automotive) along with the industry sectors of agriculture, urban development, and infrastructure.

In the same period, EO market revenues are set to double from roughly €2.8 billion to over €5.5 billion. Major contributors to this are expected to come from climate services, urban development and agriculture.

The satellite communications market size is estimated at US$193 billion in 2024, and is expected to reach US$297 billion by 2029, growing at rate of approximately 9% between 2024-2029. This is largely driven by increasing demand for high-speed internet, communication services, and data transfer across different industries.

MAYOR WEAKNESSES IN THE GLOBAL GEODESY SUPPLY CHAIN

Insufficient evidence

- There is little to no evidence available in a form that decision makers can understand which clearly explains what the global geodesy supply chain is, why investment of resources is needed, and the risks of not strengthening it.

Insufficient resources

- The funding being allocated to the operation of the global geodesy supply chain is estimated to be between €60-90 million per year worldwide, which is less than 0.05% of revenue generated from GNSS- and EO-services.
- Approximately half of ground observation stations are not-productive due to their age or lack of operational funding.
- The data collection from ground stations observatories along with quality checking, analysis and development of geodetic products is reliant on in-kind contribution and is done on a best-effort basis.

Inadequate governance mechanisms

- There is no international governance body (like the World Meteorological Organization) with responsibility for ensuring that the global geodesy supply chain meets Member State requirements, including the provision of accurate and reliable geodetic products critical to people's lives.

Decreasing capacity

- The number of geodetic professionals is declining in some parts of the world, which experts have labelled a crisis. This is due to a combination of a lack of awareness of geodesy as a career, less geodesy training options in universities, and competition for maintaining personnel when better incomes are available in other sectors.

Lack of awareness

- There is a severe lack of awareness and engagement across government, science and defence organizations who are responsible for geodesy.
- Industries reliant on satellite services for PNT applications are unaware of the global geodesy supply chain, its risk of degradation, and the risk to their stakeholders.

CALL TO ACTION

To implement United Nations General Assembly resolution 69/266, Member States and partners are forming a Joint Development Plan (to be released in August 2024) describing how they will work together to strengthen the supply chain to enhance the reliability and integrity of the geodetic products. Member States are urged to take action. Examples include:

Strengthening collaboration and coordination within each country by:

- Establishing a geodesy working group with representatives from within government (e.g. defence, science, policy) and industry. The working group could focus on:
    - Assessing the societal, environmental and economic risks due to degradation or failure of the global geodesy supply chain.
    - Translating the risks into evidence to which can be used to influence decision makers.
    - Developing national strategies to access and utilize resources to mitigate the risks.
- Officially recognizing and resourcing the global geodesy supply chain as 'critical national infrastructure'.
- Developing outreach programs that make the global geodesy supply chain more visible and understandable to society.

Strengthening collaboration and coordination within each region, and globally, by:

- Establishing a geodesy working group with regional and global representatives from within government (e.g. defence, science, policy) and industry. The working group could focus on:
    - Discussing the societal, environmental and economic risks due to degradation or failure of the global geodesy supply chain.
    - Translating the risks into evidence which can be used to influence decision makers.
    - Developing regional and global strategies to access and utilize resources to mitigate the risks.
    - Sharing data, sharing knowledge and building capacity.
- Developing formal bilateral or multilateral agreements to address gaps in the global geodesy supply chain.
- Investigating options for foreign aid investment which would support the global geodesy supply chain in foreign countries.
- Working with the UN-GGCE on efforts to strengthen the global geodesy supply chain.

REFERENCES

Euroconsult, 2022, Euroconsult estimates that the global space economy totaled $370 billion in 2021, https://www.euroconsult-ec.com/press-release/euroconsult-estimates-that-the-global-space-economy-totaled-370-billion-in-2021/ accessed 28 May 2024.

John Garamendi et al., 2015, Letter to Congress of the United States, https://rntfnd.org/wp-content/uploads/Congressional-Letter-to-PNT-Executive-Committee.pdf accessed 28 May 2024.

London Economics, 2023, The economic impact on the UK of a disruption to GNSS, https://assets.publishing.service.gov.uk/media/652eb0446b6fbf000db7584e/20231018_London_Economics_Report_GNSS.pdf accessed 28 May 2024.

Stephen Bartlett et al., A Wide-Area Multi-Application PNT Resiliency Solution' (*GPS World*, 23 Nov. 2015), http://gpsworld.com/innovation-enhanced-loran/ accessed 28 May 2024.

UK Government, 2023, National Risk Register, https://assets.publishing.service.gov.uk/media/64ca1dfe19f5622669f3c1b1/2023_NATIONAL_RISK_REGISTER_NRR.pdf accessed 28 May 2024.

UN General Assembly Resolution 69/266, 2015, https://ggim.un.org/documents/a_res_69_266_e.pdf accessed 28 May 2024.

UN-GGCE, 2024, Global Geodesy Needs Assessment, https://ggim.un.org/UNGGCE/documents/20240509-Global_Geodesy_Needs_Assessment.pdf accessed 28 May 2024