

We thank you for your time spent taking this survey.
Your response has been recorded.

If you are happy to do so, please state your name and your organisation (Optional).

British Geological Survey

What kind of respondent are you? Tick all that apply.

☐

An academic working on, or with, PNT

☐

A member of a professional body not directly related to PNT e.g. IMarEST, NI, RAes, etc.

☐

A member of a professional PNT body/bodies e.g. RIN, RNTF

☒

A member of a business that sells PNT products or services

☐

A member of a PNT related catapult organisation e.g. Satellite Applications Catapult

☒

Other (please explain here):

Public Research Organisation

☐

A member of a business that uses PNT products or services

☐

A member of the public with an interest in PNT

How many employees work at your organisation?

☐

1-9 employees

☐

10-49 employees

☐

50-249 employees

☒

250 or more employees

☐

Don't know

Which industry/industries does your business/organisation belong to? Select all that apply.

- ☐ Aviation and drones
- ☐ Agriculture/Food
- ☐ Broadcasting
- ☐ Communications
- ☐ Consumer services
- ☐ Data centres
- ☐ Defence
- ☐ Emergency services
- ☐ Energy
- ☐ Finance
- ☐ Healthcare
- ☐ Internet services
- ☐ Logistics
- ☐ Manufacturing
- ☐ Maritime
- ☐ Navigation apps
- ☐ Rail
- ☐ Road
- ☐ Space
- ☐ Quantum
- ☐ Water
- ☐ Civil Nuclear
- ☐ Chemicals

☒ **Other (please provide details):**

Magnetic and Geodetic Measurements for Geoscience Research

Which form of PNT do you work with/research/sell? Select all that apply

☒ GNSS (Global Navigation Satellite Systems)	☐ PTP (Precision Time Protocol)	☒ GEO (Geostationary Earth Orbit) PNT	☒ Multi-PNT (Systems of Systems)
☐ Space-Based Augmentation	☒ Quantum PNT	☐ Satellite Signals of Opportunity	☐ Audio and/or visual-based systems
☐ Atomic Clocks	☐ INS (Inertial Navigation Systems)	☐ Terrestrial Signals of Opportunity	☐ Jamming or signal degradation detection systems
☐ Holdover Clocks	☐ eLORAN (Enhanced Long-Range Navigation)	☐ Inertial Systems	☒ LiDAR (Light Detection and Ranging)
☐ NPL Time	☒ LEO (Low Earth Orbit) PNT	☐ Pseudolites	☒ Other

Magnetic Navigation, Main field modelling

☐ NTP (Network
Time Protocol)

☒ **MEO (Medium
Earth Orbit)
PNT**

Please select the nation or region where you are headquartered/based.

East Midlands



In your opinion, is there a viable market in GNSS-independent PNT products and services?

Note: GNSS-independent PNT: PNT products or services that can operate independently from global navigation satellite systems.

☒ **Yes**

☐ No

What are the greatest opportunities for PNT companies with a UK footprint to expand their UK market share, or increase exports?

☒ **Particular technologies (specify here)**

Quantum magnetometers and improved global maps the Earth’s crustal magnetic field. Quantum gravimeters

- ☐ Establishment of standards
- ☐ Removal/reduction of trade barriers
- ☐ Trends towards GNSS-independent PNT
- ☐ CNI legislation
- ☐ Use of national resilient PNT system (NTC and eLORAN)
- ☐ Other (please specify)

What do you think are the UK's top 3 challenges in growing the PNT market share in the short term (0-3 years) and the long term (3+ years)?

1

Challenge 1 (short term 0-3 years)

2

Challenge 2 (short term 0-3 years)

Sustained, stable funding to enable the unique magnetic and geodetic critical observatories to function and produce the essential data and outputs they produce. The British Geological Survey (BGS) [1] is the only UK organisation to measure: 1. The position of GNSS satellites orbiting the earth via precise laser ranging 2. The time-varying position of the centre of the Earth and hence define the Terrestrial Reference Frame and 3. The time-varying position of the earth's magnetic field Although institutions and the public rely heavily on BGS' PNT infrastructure and services, they largely do so without ever being aware that they exist. BGS has provided such services for decades with support from the Natural Environment Research Council (NERC) - part of the Department for Science, Information and Technology (DSIT), the defence sector and industry. However, continued provision of services at current levels is now problematic due to public sector financial pressures and increased reliance on short-term funding initiatives. PNT infrastructure must be supported to ensure the security and continued operation of critical national infrastructure underpinning UK society and the economy. Given this, BGS now seeks to secure financial support for the long-term maintenance and operation of the PNT services it provides to the nation [1]
<https://www.bgs.ac.uk/>

3

Challenge 3 (short term 0-3 years)

4

Challenge 1 (long term 3 + years)

Innovation and science funding to grow capabilities in which the UK are world leading. With such funding the UK can be world leaders of quantum PNT

(magnetic and gravity) and also take advantage of current skills and infrastructure to establish services such as space debris tracking.

5

Challenge 2 (long term 3 + years)

6

Challenge 3 (long term 3 + years)

What are the relative advantages and disadvantages of the UK's PNT market compared to international markets?

Advantages

Disadvantages

How could government most effectively build awareness and adoption of GNSS-independent PNT among critical national infrastructure and business users whose operations would stop in the event of a GNSS loss incident? *Please select the 3 most effective options.*

☐ Grants and/or loans for business R&D and innovation in GNSS-independent PNT

☐ Procurement programmes for R&D and innovation in GNSS-independent PNT

☒ **Institutional funding for public research**

☒ **Project grants for public research**

☐ Interventions to support PNT talent and skills pipeline

☐ Collaborative infrastructure and networks for GNSS-independent PNT (physical and digital)

☐ Business advisory services

☐ Guidance, regulations or legislation for CNI on PNT resilience

☐ End user industry outreach

☐ Standards and certification for GNSS-independent PNT development and adoption

☐ International collaboration

☒ **Signalling UK strengths and ambitions**

Do you have any additional suggestions for government to build awareness and adoption of GNSS-independent PNT? *Please explain below (maximum 1500 characters)*

Note: GNSS-independent PNT: PNT products or services that can operate independently from global navigation satellite systems.

Raising awareness of GNSS-independent solutions and procuring them in applications like civil and military aircraft and shipping for example. We have found a surprising lack of knowledge about this potential technology solution for GNSS-denied navigation in these stakeholder groups.

Characters remaining: 1216

What are the 3 most significant barriers to the adoption of GNSS-independent PNT technologies? *Note: Answer with reference to your customers if you sell PNT products, and/or with reference to your company if you buy/use PNT. (maximum 1500 characters)*

Primarily a lack of awareness of the potential technologies to solve these problems, for example, how to combine a magnetic sensor with a map of the Earth's magnetic field to determine location.

What are the 3 most significant drivers of the adoption of GNSS-independent PNT technologies? *Note: Answer with reference to your customers if you sell PNT products, or with reference to your company if you buy/use PNT. (maximum 1500 characters)*

Directional drilling for oil and gas sector has used magnetic navigation for decades as it is low cost and reliable. Real time corrections and algorithms have been developed and proven in the field and are well understood. Hence, proven solutions that are economically viable are a real driver. Politics and potential threats of access to current GNSS services, for example denial of service or jamming of signals.

Characters remaining: 1086

Which R&D/commercialisation sources of support have you and/or your company used?

☐ NAVISP

☐ NPL Innovation Nodes

☐ Other

☐ Innovate UK

☐ A Catapult organisation (specify here)

☒ **None of the above**

☐ DASA

☐ UK Space Agency's Unlocking Space for Business

If you've used the above sources of support, please rate these from 1 to 5, with 5 reflecting the most positive rating.

	Did not use	1	2	3	4	5
NAVISP	☐	☐	☐	☐	☐	☐
Innovate UK	☐	☐	☐	☐	☐	☐
DASA	☐	☐	☐	☐	☐	☐
NPL Innovation Nodes	☐	☐	☐	☐	☐	☐
Catapult Organisation	☐	☐	☐	☐	☐	☐
UK Space Agency's Unlocking Space for Business	☐	☐	☐	☐	☐	☐
Other, please state below	☐	☐	☐	☐	☐	☐

Any further comments on the sources of support used?

- ☐ Yes
- ☐ No

What type of additional support could strengthen the UK PNT R&D and commercialisation ecosystem? (*maximum 1200 characters*)

• A UK-owned very low Earth Orbiting satellite to collect bespoke crustal magnetic field data globally, along with a data licensing model to create commercial maps. • Support for commercialising quantum magnetometer sensors from UK Quantum Hub investments. • Development of commercially licensed algorithms and integrated systems to provide map matching and data cleaning methodology. • Support to test and validate the system under real-world conditions.

Characters remaining: 741

Which source makes up the majority of your funding?

- ☐ Grant-based
- ☐ Venture capital
- ☐ Self-funded
- ☐ Customer financed
- ☐ Other business streams
- ☒ **Other**

Have you tried to raise capital of any of these types? Select all that apply

☒ **UK grant**

☐ ESA/EU grant or contract

☐ Other foreign grant

☐ UK Venture Capital

☐ Non-UK Venture Capital

For each type of capital you have selected, explain any challenges or barriers you have faced in raising this capital
(*maximum 1500 characters*)

UK science funding via UKRI is not set up to fund this type of research so we struggle to persuade grant assessment panels to provide this type of support

Characters remaining: 1346

If you have previously attempted to raise funding for PNT R&D or commercialisation, which size of investment has been the most challenging?

☐ > £100k

☐ £100k – £500k

☒ **£500k – £1m**

☐ £1m – £10m

☐ £10m +

Any further comments on raising capital/commercialisation?
(900 characters maximum)

A failed attempt at a UKRI Innovate UK bid was withdrawn at the last moment as the largest partner realised they did not correctly understand the physics of the problem and the required effort to develop algorithms to account for magnetic variations due to height and space weather effects, and hence were unwilling to commit

Characters remaining: 574

Have you experienced challenges in risk tolerance towards PNT from investors?

☒ **Yes**

☐ No

If yes, what role could government play to increase investors' risk tolerance? (maximum 1500 characters)

Government funding to collect magnetic data maps and enable high quality sensor development would leave the final piece of the puzzle to industry, which is to integrate the data with platforms and develop the technology by third parties who are capable of doing this effectively at a much lower risk.

Characters remaining: 1199

Do you export your PNT products or services internationally? If yes, which product(s) do you export and where to?

☒ **Yes**

We sell magnetic field maps globally to oil, gas and marine navigation companies. We provide a set of free maps for public use globally. We provide Satellite Laser Ranging solutions and analysis into the International Terrestrial Reference Frame.

☐ No

Do you import any components/materials for your own PNT products? If yes, what are they and from which countries do you import them from?

☐ Yes

☒ **No**

Do you import any PNT technology, products or services and from which countries? (*maximum 900 characters*)

Characters remaining: 900

Have you faced export restrictions on your PNT products or any import restrictions on goods or components? *Please explain your experience. (maximum 1500 characters)*

We have faced export restrictions for Russian companies (amongst others)

Characters remaining: 1428

How could government influence the development of international regulations and standards to help grow the UK PNT sector? *(maximum 1500 characters)*

Characters remaining: 1500

Are you aware of the Royal Institute of Navigation's PNT Best Practices and Guidance (https://rin.org.uk/mpage/Resilient_PNT)?

☐ Yes

☒ **No**

Are you and/or your company experiencing a skills shortage in your area of the PNT industry?

☐ Yes

☐ No

If you are happy to be recontacted about your responses to this survey, please provide your email address below (optional).

lbateson@bgs.ac.uk; jecha@bgs.ac.uk; BGSPolicy@bgs.ac.uk

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