

**Written Evidence Submitted by Andy Proctor, Director, RethinkPNT Ltd
(SPA0100)**

I am writing to you after listening to, and reading the transcript from the evidence session for the UK space strategy and UK satellite infrastructure investigation, given to your committee on the 9th February 2022, in particular aspects related to Positioning, Navigation and Timing (PNT), PNT from space and Galileo.

In the session noted, your witnesses were questioned about the impact of the UK's exit from Galileo, about the position regarding any alternative to Galileo and looking forward on UK's PNT provision.

I am in perhaps a unique position to provide some additional colour to the responses given as I was involved in Galileo and then the transition away, all the way up to being one of the authors of the draft UK PNT Strategy.

For context, until November last year I was a Government official, employed by InnovateUK as an Innovation Lead for Space and PNT, but have previously been on loan to the Cabinet Office as the technical lead for PNT on the PNT Strategy, and before that the Technical Director for GNSS at the UK Space Agency, where I was the technical lead for the UK GNSS programme, the predecessor to the Space Based PNT Programme (SBPP).

Part of my role as a Government official was to represent the UK's as the Lead Delegate to the European Space Agency (ESA) Programme Board for Navigation for 8 years. I was recognised widely as one of the few Subject Matter Experts (SME) for PNT within Government.

RethinkPNT Ltd was formed on leaving Government. I am a Chartered Engineer, a Fellow and Trustee of the Royal Institute of Navigation and a Fellow of the Institute of Engineering and Technology.

In mid-2017 the National Security Advisor requested options¹ for a “plan B” with regard to Galileo, “plan A” being a negotiated settlement to remain within that programme. As the committee knows well, due to issues related to the security approach of the EU, plan A was not possible.

What seems to be missing from the evidence on the 9th Feb 2022 and previously, is some detail of what the initial “plan B” (UK GNSS) programme covered and the achievements of it. I chose not to join the SBPP when it started; the successes of the UK GNSS programme seems to have been suppressed as the programme was presented to government stakeholders by BEIS and the UK Space Agency, as toxic and pushing a single solution.

The UK GNSS programme started in 2017 and initiated (from Jan 2018) a rapid (9 months with an initial 3-month deliverable) study called the “Future Concepts Study (FCS)”, which looked at several concepts for the provision of services that could replace the services that could have been provided by Galileo.

It should be remembered that Galileo is still not fully operational in 2022, is some 12 years late from the initial estimates and approx. €8bn over the initial budget estimates. The FCS, led by a small team in the UK Space Agency with an industrial consortia and budget up to £5mn, assessed systems that can²:

- Ensure UK freedom of action so the UK can meet its security requirements and manage its critical infrastructure with appropriate assurance.
- Stimulate and support economic growth through investment in a high-skill, technology-based sector
- Provide a UK secure PNT signal commensurate with the delivery of Galileo PRS, circa 2027 and do it in a way that delivers a more favourable balance of benefits and costs than remaining in Galileo.
- Develop export potential associated with the UK secure PNT signal.

The FCS delivered several reports including sufficient information for an Outline Business Case (OBC) to further investigate a Medium Earth Orbit (MEO) solution (similar to GPS and Galileo). It did however investigate in some detail configurations to provide these services from Low Earth Orbit (LEO), similar to that proposed by OneWeb. 5 options were assessed, MEO was chosen for additional investigation due to realistic assessments against the ability of the UK (industrial and Government capability) to deliver against the strategic objectives above. The FCS also identified industrial gaps and long lead items.

Following BEIS and HMT approval the UK GNSS programme started a phase of activity, called Engineering Design and Development phase (EDDP) with a budget of around £92mn which was widely reported at the time.

I joined the programme full time as Technical Director in May 2018, prior to that I was a technical advisor only. It was immediately obvious that the civil service governance environment created around the programme was hostile towards it, (as noted by the Infrastructure Projects Authority in one of its reviews – available to the committee no doubt) with contracts for industry deliberately delayed. This included senior civil servants reporting internally and publicly (on Radio 4) that the

¹ NSA Letter to BEIS Permanent Secretary 30 June 2017, available via BEIS

² These are the strategic objectives given to the UK GNSS programme flowed down from the NSA and approved by BEIS and HMT through standard business case approval processes

expected cost of a system was £5-7bn when the OBC clearly stated that the estimated cost was £2.75bn (not counting optimism bias).

All the FCS and OBC documents should be available to the committee as they exist on the UK Space Agency servers, I no longer have access to the documentation.

The EDDP let several significant industrial contracts with secondary objectives to preserve industrial capability and prevent industrial flight (specifically of space based PNT skills overseas). These contracts were for:

- Systems engineering
- Ground Segment design and engineering
- Space Segment design and engineering
- 4 x contracts for studies into spacecraft operations best practice
- Signal in space test facility and signal generator design
- Several small user equipment studies for options analysis
- Market and commercial option analysis

These contracts, involving over 10 companies, were well received by UK industry and the quality of the outputs received by HMG was high. The long lead items identified as being essential to any future programme success were not able to be procured due to lack of approval from BEIS.

The initial 18m EDDP was extended by a few months at the request of the UK Space Agency, although the budget envelope was not broken and the outcomes came in under the overall budget initially approved. The UK GNSS programme was closed by the UK Space Agency and BEIS in September 2020.

My responsibility on the UK GNSS programme was the technical lead for HMG, leading all technical functions within the programme. Overall, the EDDP, from a technical only standpoint, delivered on all its aims; it delivered

- outline designs for a UK GNSS system, with significant depth of technical requirements to enable further industrial contracting
- mature design for the ground segment, including a unique UK sovereign Orbit Determination and Time Synchronisation (ODTS) capability, which is the beating heart of an independent space-based navigation system.
- several options and configurations for spacecraft including multiple services, launch options and security profiles
- assessments of technical signal structures and proposed UK specific secure signal options
- a UK GNSS test bed; a highly capable facility able to simulate different types of system and signals, including test user equipment for secure signal design
- design options for generation of the complex PNT signals on board the spacecraft
- the development of a number of young engineers by exposure to GNSS concepts and engineering

The EDDP also delivered a credible rough order schedule and budget for a 30-year horizon, proposed commercial models for best value implementation and conducted a UK supply chain assessment for PNT systems together with an assured capability analysis.

It proved that:

- The design and implementation of a UK GNSS at Medium Earth Orbit delivering secure PNT signals, meeting the UK security requirements, before the Galileo PRS system was expected to be fully operational, was possible from a technical/industrial standpoint.
- HMG had identified the UK strengths and weaknesses for delivery of such a system
- There was sufficient goodwill in the space sector to co-invest in a UK GNSS

Some aspects of the programme were not completed, namely documenting the user requirements extrapolating from the direction and guidance received from the NSA. This, together with change in senior civil servants in the UK Space Agency, the Cabinet Office and BEIS, meant that the institutional knowledge as to the initial direction given was lost, and those new leaders decided to close the programme. The budget at close was in the order of £65-70mn, mostly spent with industry, but delivered the points above.

I do not think that this detail about the technical success of the UK GNSS programme has been provided to the committee previously. Many hundreds of design documents were delivered as part of this programme, and these can be available to the committee from the UK Space Agency. The technical aspects of the UK GNSS programme should be recognised as a technical success and celebrated.

The UK Space Agency's SBPP programme also assessed options for space based PNT and started from a similar place as the FCS. It presented a few additional options, although the initial constraints on the UK GNSS were slightly different to that of the SBPP. One important update from the SBPP was to revise the report published in 2017, commissioned by myself through InnovateUK, which provided the £1bn/day (over 5 days) figure as the economic impact of the loss of GNSS to the UK economy³. The revised report has yet to be published and the UK Space Agency have not stated they have a current plan to do so. It would be helpful to the committee and the sector for it to be published.

Between October 2020 and July 2021 I was loaned to the Cabinet Office via a small team housed within the UK Space Agency as the Technical Lead for PNT and one of the authors of the UK Draft PNT Strategy.

The committee evidence correctly identified that the wider cross-government PNT strategy does not sit within the UK Space Agency, and it is important to recognise this. The Cabinet Office are in the process of delegating this responsibility to BEIS and my understanding is that at the time of writing, implementation of the PNT strategy has not been started within BEIS.

The PNT Strategy had a core team of authors but consulted with over 85 sector (industry and academic) experts, including users of PNT and operators of PNT services. Additionally, a period of cross-government policy staffing was carried out. The core recommendations of this draft UK PNT Strategy are:

- improve UK national resilience by developing a System of Systems⁴ approach to deliver Assured PNT services. Combining ways of protecting and defending our access to legacy services;

³ The economic impact on the UK of a disruption to GNSS, London Economics, April 2017

⁴ An approach endorsed by DNSA Sizeland and Director Capability Barlow July 2020

- developing new, robust and assured systems that preserve the many advantages gained from access to ubiquitous PNT services; providing further diversity and redundancy options and a new range of innovative, complimentary on-platform solutions; all supported by appropriate standards, legislation, skills and training to meet the performance needs of the future

The evidence document compiled for the strategy assessed around 20 years of evidence (including case studies and requirements gathering) on the issues surrounding PNT and the lack of resilience of UK infrastructure, it noted that the UK needed:

- a comprehensive PNT Strategy to deliver improved resilient PNT information for UK critical services
- a cross-government body to:
 - Coordinate the implementation of a system of system approach.
 - Develop and implement the architecture framework.
 - To derive PNT System of systems, system requirements.
 - Coordinate cross Government PNT Research & Development, including a focus on atomic clock manufacturing.
 - Form a PNT Skills and training unit.
 - Document the legislation and regulation evidence base.
- a national PNT / Radio Frequency Interference Detection and Monitoring system
- a national PNT testing capability and an appropriate conformance framework. (A framework was presented in the draft PNT strategy)

These are mostly specialist technical functions, requiring specialist PNT knowledge. The implementation plan provided also documented and costed the resources required to deliver against the recommendations.

These documents can be made available to the committee through the UK Space Agency and/or BEIS.

The relevance to your investigations here is that space is seen as an essential part of the PNT mix, which was endorsed at a presentation to Secretary of State Sharma in July 2020, by the Cabinet Office and UK Space Agency teams, meaning that the National Space Strategy should acknowledge the need for UK Space Based PNT investment⁵, just as much as it correctly acknowledges navigation applications as a growth area.

The evidence provided for the NSS notes that navigation (and by extension PNT) is a hugely growing market with lots of UK potential, however UK investment in PNT is declining from the peak of being involved in Galileo (which returned a greater value of contracts than contribution, after rebate) to now, where there is no dedicated PNT technology development programme save the ESA Navigation Innovation and Support Programme (NAVISP), and those within the Ministry of Defence.

⁵ This does not equate to a full GPS or Galileo “like” system, or even a OneWeb “like” system, a regional system similar to EGNOS can provide many of the strategic benefits noted herein and improve capabilities for (for example) supply chains in the UK.

I hope this submission gives additional colour to your discussions including that the committee should review documents relating to, and the recommendations of, the draft PNT strategy for the UK, given that it has a direct relevance to the space strategy and space infrastructure.

The committee should also consider the overall reduction in PNT investment across government and if this is appropriate while the market opportunities are rising, and other nations are investing. Assessing and comparing the spend versus deliverables between the UK GNSS programme and the SBPP programme would also provide some insight into the options analysis.

To reiterate, my input here is that as the Director of RethinkPNT in response to the evidence given on the 9th Feb 2022 and no other role.

However, I note from other witnesses that the general input regarding PNT is consistent across multiple submissions. Our critical infrastructure is at risk from the loss of PNT, space based or otherwise. We are currently critically dependent upon GPS; the loss of which will have a major impact in capability and economically. HMG disinvested in the eLoran terrestrial system that could have provided a backup, although this is slowly reversing.

For 20 or so years there have been calls for action, yet the current status of inaction regarding the PNT strategy puts our systems at increasing risk, especially given the clear and present electronic warfare systems being used in Europe today. Finally, the committee should consider why SME's in PNT like myself are leaving Government and not being replaced when clearly the highly technical skills are required within Government.

(7 March 2022)