Innovation Launchpad Network+

CASE STUDY

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The Challenge

Positioning, Navigation and Timing (PNT) services are a critical part of modern infrastructure, underpinning everything from transport systems to telecommunications and defence operations. At present, most PNT services rely heavily on Global Navigation Satellite Systems (GNSS), such as GPS. While widely used, these systems have well-known limitations. Signals can be degraded in urban environments, disrupted by interference, or even deliberately spoofed or jammed, raising concerns around reliability and security. These vulnerabilities are particularly problematic for fast-moving platforms such as cars, trains and aircraft, where accurate, continuous positioning is essential for both safety and performance. As demand grows for autonomous systems and more resilient infrastructure, there is an urgent need for alternative approaches that can provide higher accuracy and greater robustness. One promising direction is the use of Low Earth Orbit (LEO) satellite constellations, which operate closer to Earth and can offer improved signal strength and coverage. However, effectively harnessing these systems for real-time, high-precision localisation presents significant technical challenges, particularly in maintaining continuous connectivity and handling rapid movement. This project set out to address these challenges by developing a new approach to localisation that is more secure, accurate and resilient, with the potential to support next-generation transport systems and critical national infrastructure.

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To address the limitations of existing PNT systems, the project developed a novel intelligent antenna architecture designed to work with Low Earth Orbit satellite constellations. Unlike traditional systems that rely on a single satellite link, this approach enables simultaneous connectivity with multiple satellites, significantly improving both reliability and accuracy.

The antenna is capable of connecting to up to three Starlink satellites at different downlink frequency bands, allowing it to capture and process timing information from multiple sources at once. This multi-beam capability is combined with advanced beam-steering technology, enabling the antenna to rapidly track satellites as they move across the sky and switch seamlessly between them when needed.

A key innovation of this system is its ability to maintain uninterrupted connectivity even for fast-moving vehicles. By enabling rapid handovers between satellites and continuously optimising signal acquisition, the antenna ensures consistent performance in dynamic environments. This makes it particularly well suited to applications such as connected and autonomous vehicles, rail systems and aviation.

Overall, the project represents a shift from reliance on traditional GNSS towards a more flexible and resilient architecture that leverages emerging LEO satellite networks to deliver enhanced positioning capabilities.

Result

The project demonstrated that the new antenna architecture is a highly promising solution for next-generation localisation systems. Testing showed that the system can reliably connect to multiple LEO satellites and maintain stable performance, even under conditions where traditional GNSS signals may struggle.

One of the most significant findings is the potential for achieving positioning accuracy at the level of a few centimetres, representing a substantial improvement over conventional satellite-based systems. This level of precision opens up new possibilities for applications that require extremely accurate and real-time positioning, including autonomous transport, advanced logistics and defence operations.

The results also confirmed the flexibility of the approach. The antenna is not limited to a single satellite provider and can be adapted to work with different LEO constellations, making it a scalable and future-proof solution as satellite networks continue to evolve.

In addition to technical performance, the project provided valuable insights into system design, signal processing and integration challenges, helping to define the next steps required to move from prototype to deployment. These findings lay a strong foundation for further development and commercialisation.

Impact

This project has the potential to significantly reshape how positioning services are delivered, particularly in applications where accuracy, reliability and security are critical. By moving beyond traditional GNSS and leveraging LEO satellite constellations, the new antenna architecture offers a pathway towards more resilient and precise localisation systems.

The ability to achieve centimetre-level accuracy in real time could enable major advances in sectors such as autonomous vehicles, smart transport infrastructure and defence. For example, it could support safer navigation for driverless systems, improve coordination in complex logistics networks, and provide more secure alternatives to GPS in sensitive applications.

Importantly, the technology also aligns with the UK's strategic ambition to develop sovereign PNT capabilities. By reducing reliance on external systems and enabling new domestic solutions, it contributes to national resilience and technological leadership in a rapidly evolving field.

More broadly, the project introduces a new paradigm in satellite-based positioning through its multi-beam and fast beam-steering approach. As LEO constellations continue to expand, this innovation positions the UK to take advantage of emerging opportunities in advanced navigation technologies and next-generation connectivity.

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~~"This RiR demonstrated the power of embedding academic expertise in a translational setting, delivering practical, high throughput approaches to LNP development that are directly relevant to manufacturing." - **Daragh McLoughlin**~~

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~~"This project changed how we think about LNP development — embedding high throughput screening and manufacturability from the start revealed critical drivers of mRNA potency that traditional approaches miss."~~

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