CASE STUDY

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The Challenge

Space is becoming crowded. By 2030, the active satellite population is expected to climb from 14,000 today (November 2025) to many tens of thousands, yet today's space surveillance and tracking (SST) systems deliver kilometre-level orbit errors. This lack of precision leads to hundreds of thousands of false collision alerts every day and forces operators to execute costly avoidance manoeuvres without knowing which warnings to trust. There is also no widely accepted way to assess the absolute three-dimensional accuracy of orbit data, creating a trust gap between data providers and end users. In early 2023, we asked the following: can we bridge the gap between the state-of-practice in non-cooperative tracking (kilometre-level uncertainties) and state-of-the-art (centimetre-level accuracy) in precise orbit determination? The Researcher-in-Residence (RIR) project set out to develop an on-orbit calibration system that leverages scientific satellites as reference standards to improve SST accuracy across all orbital regimes and deliver trustworthy orbit solutions to operators and policymakers.

Innovation Launchpad Network+

Innovation

Over the course of the RIR project we devised the Orbit Domain Calibration (ODC) method and built OrbitNet, a curated catalogue of more than 200 satellites with centimetre-level precise orbits spanning low-Earth to geostationary altitudes. ODC treats these precise orbits as on-orbit reference standards to calibrate and correct the outputs of uncooperative tracking systems. We ran proof-of-concept tests on GRACE-FO (2023) and Sentinel-1 (2024) data and developed quality-assurance protocols—including manoeuvre detection and post-manoeuvre masking—to ensure reliability. The project was more than a technical exercise: the Catapult provided strategic direction, dissemination platforms, and introductions to UCLB (technology transfer office), which allowed us to draft patentable implementations and develop a spin-out company to productise the technology. The approach scales existing SST infrastructure by adding a correction layer rather than requiring new sensors.

Result

On-orbit tests demonstrated that ODC can deliver dramatic accuracy gains. For the GRACE-FO mission the median three-dimensional position error in uncooperative tracking dropped from about 600 metres to roughly 20 metres (≈30× improvement), while the root-mean-square error fell from about 4 kilometres to 200 metres (≈20×). For Sentinel-1 the method achieved roughly a twofold accuracy improvement and halved the positional uncertainty. During the project, we identified more than 200 suitable satellites for inclusion into OrbitNet across all operational regimes, and a 15-satellite low-Earth-orbit reference network showed how to detect manoeuvres and mask affected data for up to 48 hours. These results advanced the technology from TRL 1–2 to TRL 4. The project generated an invention disclosure; patent drafting commenced and OrbitNet branding work began; and a project to form a spin-out was initiated. Stakeholders expressed strong interest: the UK NSpOC provided a letter of support. Dissemination included three conference papers, presentations at COSPAR 2024, ESA Space Debris 2025 and AMOStech 2025, national workshops and briefings, and a feature on the Catapult's "In-Orbit" podcast.

Impact

The Orbit Domain Calibration (ODC) and OrbitNet initiative address a critical "trust gap" in global space surveillance. By repurposing scientific satellites as centimetre-level reference standards, the project demonstrates that orbit uncertainty for uncooperative objects can be reduced by up to 20x.

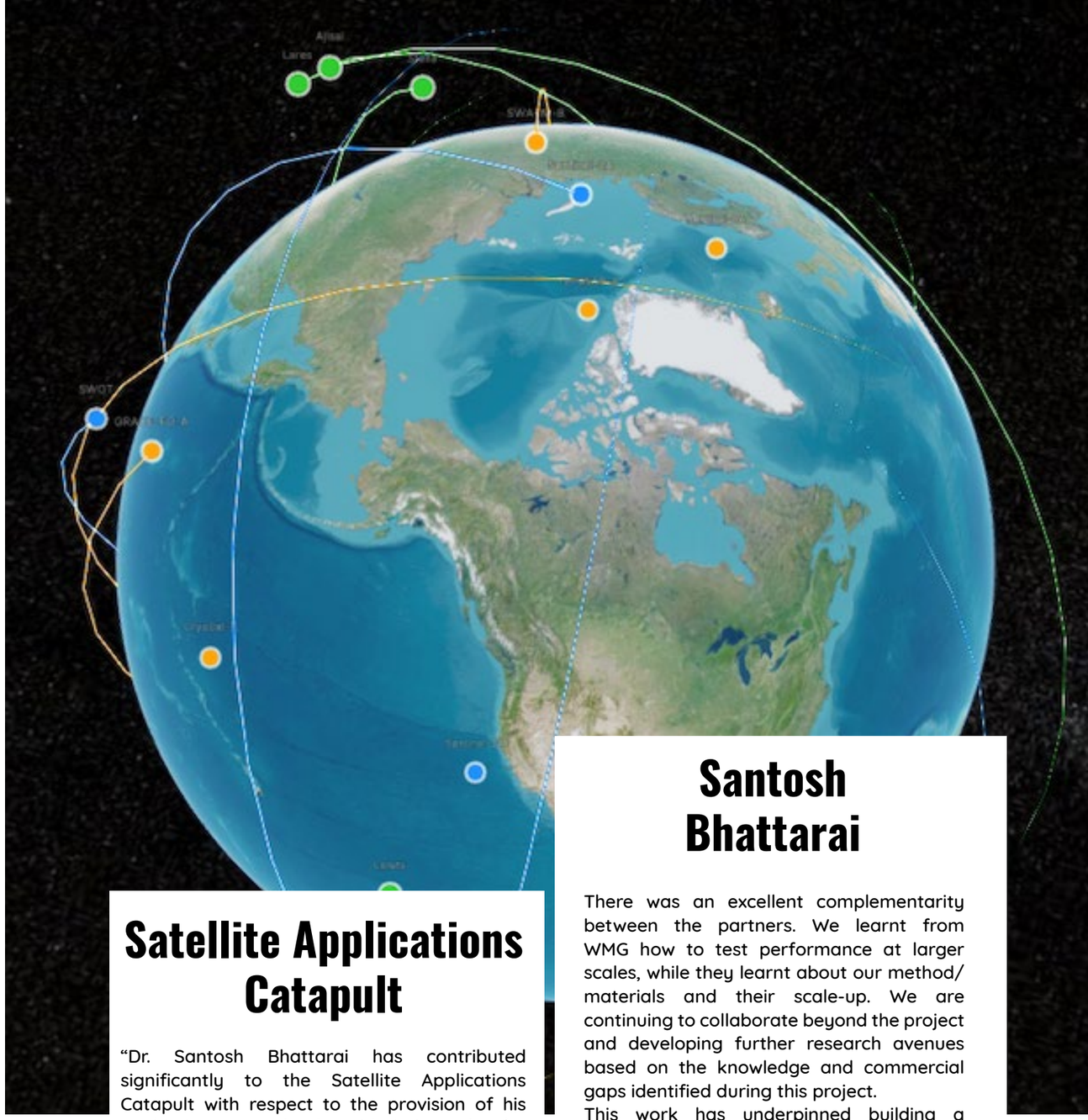
This could change the sector in three ways:

Operational Efficiency: Currently, operators face roughly 600,000 alerts daily, leading to costly, often unnecessary manoeuvres. ODC provides a cost-effective correction layer that reduces these false alarms without requiring expensive new sensor hardware.

Standardisation: The project establishes a "gold-standard" for ephemeris (orbit data) quality assurance, moving the industry away from a reliance on limited geodetic spheres toward a robust, 200+ satellite reference network.

Economic Value: With satellite operators exposed to costs of approximately $30,000 per satellite annually (for collision risk management) arising from orbit data uncertainty, this technology targets a global opportunity exceeding $360 million6.

Potential: The successful advancement from TRL 1-2 to TRL 4 has already catalysed the formation of a university spin-out company to productise the OrbitNet-ODC combined system. An new 10-week, £60k POC project, supported by the UK National Space Operations Centre (NSpOC), is positioned to scale the system to constellation-level tests (>100 objects) and firmly establish a new community calibration framework for international space safety.



Satellite Applications Catapult

"Dr. Santosh Bhattarai has contributed significantly to the Satellite Applications Catapult with respect to the provision of his world-class expertise in orbital dynamics for orbit prediction and precise orbit determination. His skillset has been exceptionally valuable to our organisation; the partnership has accelerated knowledge transfer, as Santosh brought academic insights in this critical subject area that complemented the Satellite Applications Catapult's industry-driven strategy." - Gary Cannon

CATAPULT Satellite Applications

Santosh Bhattarai

There was an excellent complementarity between the partners. We learnt from WMG how to test performance at larger scales, while they learnt about our method/ materials and their scale-up. We are continuing to collaborate beyond the project and developing further research avenues based on the knowledge and commercial gaps identified during this project.

This work has underpinned building a venture and the formation of a spin-out company. Specific technical developments are identified now, which include process scale-up and product development. They form the basis for first 1-2 years of the spin-out company's technology development goals. Using these results, we have built a pitch-deck and a detailed business plan to raise investment.

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