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When the signal fails: our hidden dependence on GNSS

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When I taught my children to drive, I discovered something that genuinely unsettled me. When I suggested we take this street or that road to get somewhere, they looked at me as though they were lost. And in a way, they were.

Having grown up in a world of smartphones and Google Maps, they'd never had to remember street names or phone numbers. If they needed to know, all they had to do was ask their phone.

I suspect many readers will have had a similar experience. Satellite-enabled technology has become so ingrained in our daily lives that we barely notice how dependent we've become on it.

And this is where things start to get uncomfortable.

Most people still think of satellites as navigation aids. Something that lives on a screen as a moving dot on a map, a turn-by-turn instruction and therefore a convenience we take for granted.

But global satellite navigation systems (GNSS) now underpin far more than directions.

Positioning, navigation and timing (PNT) form an almost invisible infrastructure behind much of modern life. In fact, many people working in this field would argue, quite rightly, that it's timing that matters most. Precise timing signals synchronise telecommunications networks, financial transactions, power grids, logistics chains, emergency services and transport systems. GNSS doesn't just tell us where we are, it tells systems when things happen and in what order.

That reliance brings risk.

Loss or degradation of GNSS is often discussed in the context of defence or aviation, but the implications extend far beyond those sectors. A systemic disruption to positioning or timing doesn't fail neatly. It cascades. Small errors compound.

As a kid, I was fascinated by chaos theory and the idea of a "sensitive dependence on initial conditions" and that phrase has been looping in my mind more and more when I think about GNSS fragility. Systems that were never designed to question their source of truth continue operating on flawed assumptions, while errors quietly accumulate and a snowball turns into a wrecking ball.

While deliberate jamming and spoofing have attracted attention in recent years, particularly around geopolitical flashpoints, they're only a part of the picture. GNSS signals are also vulnerable to environmental disturbances, infrastructure masking, interference from other electronic systems, software faults, power failures and design limitations that sometimes only reveal themselves under stress.

What matters most though, isn't the cause, but the consequence. A loss of trusted position or time across interconnected systems has the potential to be catastrophic.

For countries like Australia, this isn't an abstract concern. As an island nation heavily reliant on maritime trade, energy imports and tightly coupled logistics networks, disruption at key nodes would be felt quickly and widely. During COVID, aviation groundings were highly visible and yet the economy continued to function because ports and shipping kept moving. That experience should tell us something about where some of our deepest systemic dependencies really lie and what we ought to regard as critical infrastructure.

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Modern ports, transport hubs and industrial facilities increasingly rely on GNSS-enabled systems not just as aids, but as enablers. Precise positioning allows larger assets to operate in tighter spaces. GNSS-derived timing synchronises lighting, communications, cargo handling, security and scheduling systems. Over time, these dependencies accumulate, often quietly, until satellite signals become a single point of failure hiding in plain sight.

Internationally, governments and infrastructure operators are beginning to confront this reality. Frameworks for resilient PNT are emerging across Asia, Europe, North America and through United Nations-affiliated bodies. The themes are consistent in terms of layered systems, diversity of technology, detection of interference, integrity monitoring and the ability to degrade gracefully rather than catastrophically.

Importantly Australia's not starting from zero. Research institutions, technology developers and infrastructure operators already possess much of the expertise needed. In fact, Australia provides navigation and timing technology relied on by the United States military to measure and test GNSS failure. What's been missing, until recently though, is a coordinated pathway to translate that capability into deployable, trusted solutions at scale.

And that gap is precisely what the SHIELD Cooperative Research Centre is designed to address.

SHIELD's focus is not on replacing GNSS, but on reducing over-reliance by building resilient, sovereign PNT capability for critical infrastructure. That includes detecting when signals are compromised, augmenting satellite navigation with complementary technologies, protecting integrity under attack or interference and ensuring governance keeps pace with technical reality.

Crucially, it also recognises that resilience is not purely a technical problem. People sit at the centre of these systems. Training, trust, decision-making and organisational ownership determine whether technology becomes a safeguard or a liability.

It may be an uncomfortable truth, but GNSS disruption is not a question of if, but when. As with many complex systems, the more precise and efficient they become, the more brittle they are when their assumptions break.

Because when positioning and timing fail, it's not the satellite that pays the price. It's the systems and the society that depend on it that feel the pain.

I said it at the end of the last piece on GNSS dependence, but I'll say it again for good measure.

It's time.

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WRITTEN BY

Matt Shirley

CEO & Co-founder, Safe Harbours Australia

Safe Harbours Australia

Independent maritime consultancy delivering trusted judgment and real-world impact across port safety, risk, and operations.

CONTACT

consultants@safeharbours.com.au

+61 438 752 500

LinkedIn

www.safeharbours.com.au

Independent Maritime Consultancy · Australia