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When GPS fails: why maritime needs resilient navigation

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Some nations and ports are already taking action; most remain exposed. Image: iStock.

Every day brings new reports of GPS interference affecting shipping, particularly in regions like the Persian Gulf. Less visible are the collisions, groundings, and near misses that follow when positioning becomes unreliable.

For an industry now built around continuous, high-accuracy satellite navigation, these are not isolated incidents. They're early signals of a much broader vulnerability.

And without navigation and maneuvering solutions that allow safe operations even in the face of interference, maritime is going to see a lot more, and possibly a lot worse.

Chosen and implemented properly, systems to complement and backup GPS will not only make shipping safer, but will enable greater efficiencies and automation moving forward.

Danger at sea

GPS has made maritime operations of all kinds safer and more efficient. GPS enabled AIS has reduced the number of collisions and improved harbor and near-shore operations. The size and procedures for bridge crews have been modified. Container and other port operations have been streamlined. Over the course of several decades the industry has restructured itself around those benefits.

It only stands to reason that when GPS is not available, things are going to be less safe and less efficient. And we have more than enough examples:

- In June 2025, the 1,100 foot (335m) tanker Front Eagle, carrying approximately 2 million barrels of crude oil in the Gulf of Oman, made a quick and sharp right turn that resulted in a collision with Adalynn, a 900 foot (275m) tanker. GPS was being interfered with in the area and was a likely cause.
- In May 2025, GPS interference was blamed for the grounding of the 912 foot (278m) container ship MSC Antonia near the port of Jedda. The ship grounded on Eliza Shoals.
- In July 2019, the tanker Stena Imperio was lured into Iranian waters by GPS spoofing and was seized by the Revolutionary Guards in retaliation for the seizure of a vessel by UK forces.

Thousands of vessels are impacted by interference with GPS each year. While the Baltic, Black Sea, eastern Mediterranean, Persian Gulf, and other conflict areas are hot spots, there is scarcely a region in which it cannot be found. A 2019 German Aerospace Center (DLR) study on an 18 month voyage from the Mediterranean to the far east and back detected interference during every segment of the trip - port, coastal, and even open sea transit.

Pirates, theft & smuggling

Interference with weak and easily imitated GPS signals has also been linked to cargo theft. In one well publicized instance, celebrity chef Guy Fieri lost $1,000,000 of his branded tequila to hijackers that used GPS spoofing to divert the shipment.

Officials in the U.S. have reported spoofing used to steal pharmaceuticals, and jammers or spoofers are regularly used in the theft and illegal export of luxury vehicles.

Across the globe, vessels spoof their own locations to help conceal a broad range of illicit and illegal activity. The Russian “shadow fleet” transporting sanctioned oil is merely one example.

It could even be possible for bad actors to hijack an entire vessel without the crew being aware until their last moments. In 2013 Professor Todd Humphreys and his students at the University of Texas demonstrated just how that could happen on a yacht in the Mediterranean. A 2017 article in Maritime Executive magazine outlined how this could be done fairly easily to hijack an oil tanker sailing from the Cape of Good Hope to the Straits of Malacca.

Deep sea solutions

While much recent focus has, quite understandably, been on interference with GPS and other Global Navigation Satellite Systems (GNSS) in deep sea and conflict affected regions, the maritime industry is not standing still. There’s growing recognition that reliance on a single vulnerable positioning source is no longer acceptable, and that more resilient approaches are required.

Maritime authorities and industry bodies, including regulators, classification societies, and organisations such as the IMO, ICS, OCIMF, INTERTANKO, and The Nautical Institute, are increasingly addressing GNSS vulnerability at both operational and training levels. This includes guidance for operating under degraded GNSS conditions, stronger emphasis on cross checking and situational awareness, and consideration of alternative positioning, navigation and timing architectures.

In parallel, a range of technologies are emerging to detect, augment, or complement established GNSS. Satellite based augmentation such as Iridium STL and systems like PNTGuard provide independent timing and positioning inputs. Terrestrial and hybrid approaches including R mode, eLoran and other radio based systems are already available or moving from concept toward deployment in some regions. At the same time, interference detection systems such as those developed by Calian, Griffin, Viavi, and UHU Technologies are enabling real time awareness of jamming and/or spoofing activity.

Taken together, these developments show that the deep sea challenge is being recognised and progressively addressed through a combination of detection, augmentation, alternative systems, and improved awareness.

However, they also highlight a critical gap. As vessels move from open water into coastal and port environments, the level of positional precision required increases significantly.

The port problem

Modern ports have evolved into highly optimised and tightly coupled operational systems.

Vessel size has increased, margins have reduced, and infrastructure from berth design to under keel clearance systems is increasingly built on an assumption of continuous, high accuracy positioning. In this environment, GNSS is no longer simply an aid to navigation. It is an essential input into the way ports function, and this changes the nature of the risk.

Incidents already observed at sea, including collisions, groundings, and loss of control linked to unreliable positioning, offer an indication of what could occur in more constrained port environments. What may be manageable in open water becomes far less forgiving in restricted channels, high traffic approaches, and alongside fixed infrastructure.

In some ports, vessel size and configuration have already moved beyond the limits of traditional visual navigation. Safe pilotage is now heavily dependent on GNSS based positioning, often supported by portable pilot units (PPU’s) and integrated bridge systems.

This dependency is most acute where margins are tight. Channel widths have not increased at the same rate as vessel size, under keel clearance is closely managed, and visibility may be limited by weather or vessel configuration. As reliance on GNSS increases, the ability to independently verify position often decreases. In these conditions, small positioning errors can quickly escalate into grounding or contact risk.

The consequence is not only the potential for a single incident, but a broader operational vulnerability. A loss of confidence in positioning, even without an incident, may be enough to prevent vessels from entering or departing a port.

It’s also important to note that the impact doesn’t stop at the marine interface. Many terminals rely on satellite derived positioning and timing for logistics, security, and equipment control, including automated or remotely operated systems. Disruption to GNSS therefore has the potential to affect both marine and landside operations simultaneously.

In tightly scheduled shipping networks, even a single missed berthing window can have immediate operational consequences beyond the vessel itself.

The scale of this risk is well illustrated by events such as the Ever Given grounding in the Suez Canal, which delayed an estimated 10 billion US dollars of trade per day. While not all of this represents direct economic loss, it highlights the way disruption in a constrained system can have immediate global consequences, with longer term impacts that are harder to quantify.

In this context, GNSS disruption in ports is not simply a navigational issue. It’s an operational constraint with the potential to extend far beyond the port itself.

Observed reality

This is not a hypothetical risk.

GNSS interference in port vicinities is already being recorded across the globe, with detection systems identifying spoofing and jamming events hundreds or thousands of times each day. While many of these incidents are linked to low-level uses such as personal jammers on land, they demonstrate both the accessibility of the technology and the frequency with which positioning signals are disrupted.

The potential for these effects to extend into aviation and port environments is therefore not theoretical. In aviation, the impacts are increasingly visible and well understood. In port environments, they are less well documented, but no less plausible. The conditions that enable disruption already exist.

The question, therefore, is not whether GNSS disruption can affect port operations, but whether ports are prepared, or ready, to operate safely when positioning can no longer be assumed.

A resilient port approach

A resilient port approach is already within reach.

A combination of practical solutions provides a pathway to more robust positioning in port environments. Interference detection systems as mentioned above can deliver real time awareness of jamming and spoofing, enabling operators to identify and respond to disruption early.

At the same time, localised positioning systems, such as Locata, provide an independent terrestrial alternative to satellite based navigation. Using nearby ground based transmitters and stronger signals, these systems are inherently more resistant to jamming and spoofing than distant GNSS signals. When integrated with GNSS and supported by interference detection technologies, they enable operators to identify degraded or unreliable signals, cross check positioning data, and maintain accurate and trusted positioning during what might otherwise become a full scale disruption or loss.

Together, these capabilities represent a shift from passive reliance on GNSS toward deliberately engineered positioning resilience, while also providing ports with greater control over critical navigation infrastructure.

And it’s at this interface between sea and shore that positioning resilience becomes essential, where tightly coupled operations mean failures can quickly translate into broader consequences.

The resilience dividend

While much of the discussion around positioning resilience is framed in terms of risk reduction, there’s also a clear operational upside.

More reliable and assured positioning has the potential to improve efficiency as well as safety. If positioning integrity can be maintained despite interference, poor visibility, or space weather effects, operations are less likely to be delayed, degraded, or halted. This creates greater consistency in vessel movements, berth utilisation, and terminal throughput.

In constrained port environments, where margins are already tightly managed, improved confidence in positioning may also support more precise operations. This has the potential to influence the way under keel clearance is managed, when weather or visibility restrictions are applied, and the enforcement of otherwise conservative buffers set around vessel movements.

Over time, this increased reliability also has the potential to enable ports to operate with greater predictability. Improved confidence in arrival windows and turnaround performance supports more stable scheduling, reduces inefficiencies across terminal and landside operations, and could well contribute to better utilisation of existing infrastructure.

But there’s also a longer-term benefit. As positioning becomes more resilient and less dependent on a single system, it may begin to influence the way ports are designed, upgraded, and expanded. Assumptions around navigation margins, channel utilisation, and operational constraints could shift, allowing for more efficient use of available space and capacity.

In this sense, positioning resilience is not only a safeguard against disruption, but a potential enabler of more efficient and reliable port operations. In a world where sustainability and continuity of supply are increasingly critical, ensuring the reliable flow of essential goods is not just an operational objective, but a necessity.

Global reliance

The implications extend beyond the port. Modern supply chains operate on tightly synchronised, just in time models, where disruption in one location propagates rapidly across shipping schedules, terminals, and inland logistics.

What begins as a positioning issue at the ship or port level can therefore translate into systemic supply chain disruption, with consequences that extend well beyond the maritime domain. Seen in this context, the need for resilient navigation is not only a technical or operational concern, but a fundamentally human one.

Who acts, who pays?

The need to safeguard current operations and lay the groundwork for future efficiencies is clear. Mature technologies are available, and while they are not inexpensive, their cost is small when compared to the potential consequences of major ecological damage, significant trade disruption, and loss of life.

What remains is the question of who takes responsibility for ensuring these solutions are in place. And that is as much, if not more, a political and commercial question as it is a technical one.

Commercial shipping, cargo owners, shippers, and those who insure them have the most to lose in mishaps, and the most to gain by preventing them. Ports have an equally vested interest in maintaining safe and efficient operations, and will greatly benefit from the increased efficiencies truly precise and resilient navigation will bring.

Nations also have a role to play. Governments have long provided aids to navigation such as lighthouses, buoys, daymarks, and a variety of electronic aids as a way of protecting and boosting their nation’s economic and national security.

Yet, at the moment, despite the turmoil in the Middle East, few in the industry and governments seem to be concerned about either the open water or port problem.

There are, however, some notable exceptions. The United Kingdom and France are addressing open water and harbor navigation by establishing eLoran networks similar to those in operation in South Korea, Saudi Arabia, China, and Russia. At a local level, some ports are exploring and implementing the use of terrestrial positioning systems such as Locata to provide reliable, centimeter-level positioning that can be used in confined waterways and for container operations.

However, these examples remain the minority.

Which brings the question back into focus. Who will act, and who will pay? Or, what will it take? A major failure with lasting economic and political consequences? Or leadership willing to invest ahead of that moment, and ensure the infrastructure needed to protect and advance the maritime system is in place before it is tested?

As is being demonstrated in different ways right now, nations that have invested in protecting themselves against geopolitical disruption are able to absorb and manage supply chain impacts. Those that have not are left to respond in real time, often at greater cost, and with fewer options.

In a system now built on precision, timing, and continuous positioning, that distinction is no longer theoretical. It is operational. It is human. And it is a choice.

This article was co-authored by Captain Matt Shirley, CEO & Co-founder of Safe Harbours Australia, and Captain Dana A. Goward, President of the Resilient Navigation and Timing Foundation. It was first published in Hellenic Shipping News.

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