

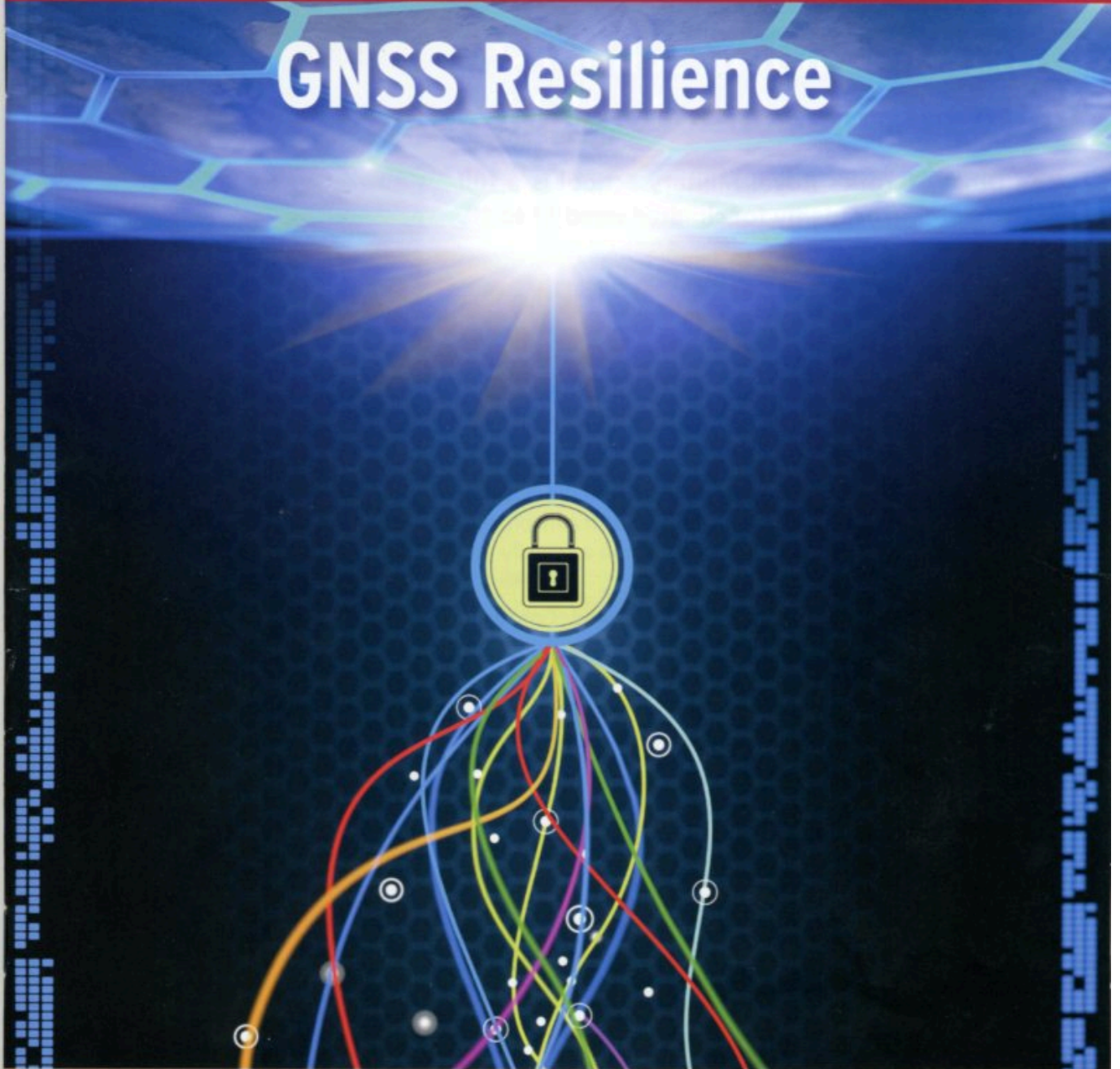
# Navigation news

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## GNSS Resilience



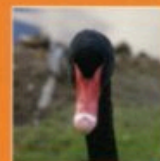
### The Navigation of Navigation

How we got to where we are with GNSS



### Resilience Has A Name

Its name is eLoran

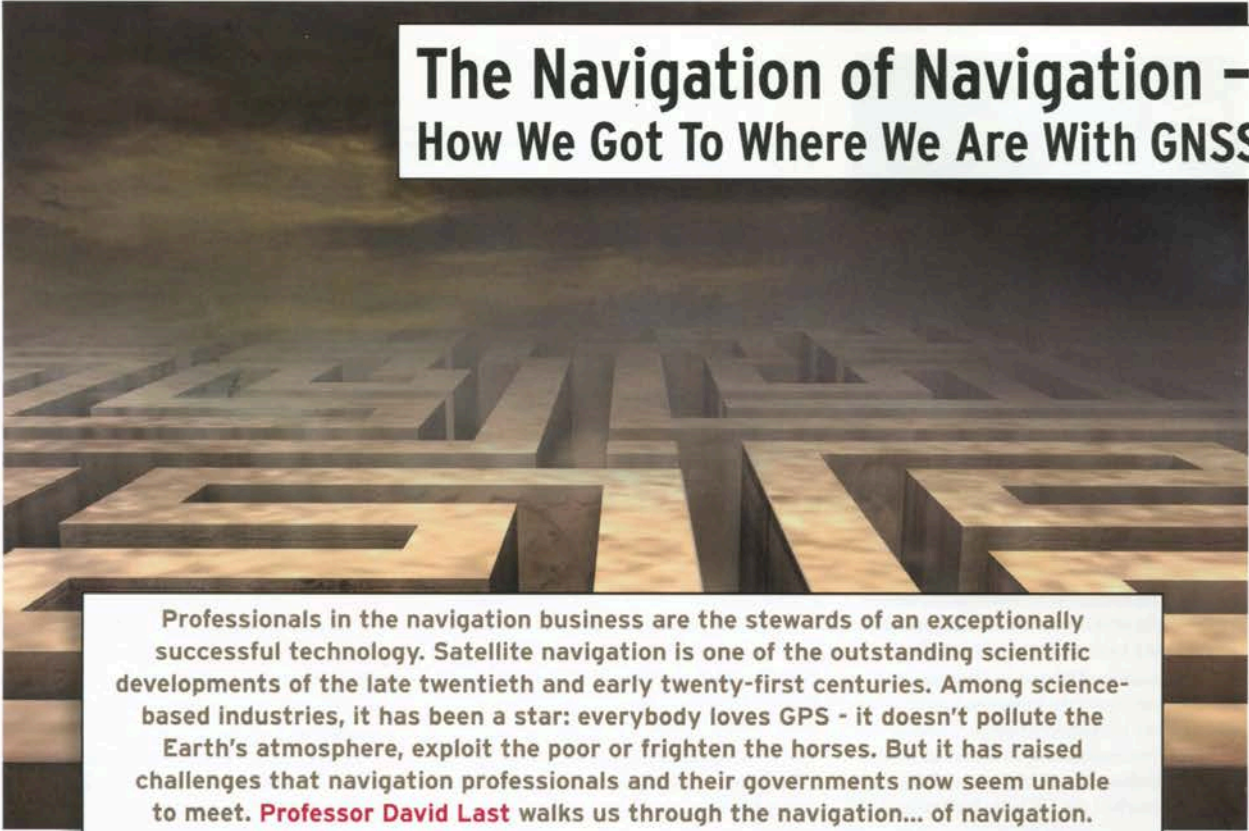


### The Black Swan and the SENTINEL

Mitigating against the unexpected

**PLUS** International News, Navigation Events, RIN News, People, Places and much more...

# The Navigation of Navigation - How We Got To Where We Are With GNSS



Professionals in the navigation business are the stewards of an exceptionally successful technology. Satellite navigation is one of the outstanding scientific developments of the late twentieth and early twenty-first centuries. Among science-based industries, it has been a star: everybody loves GPS - it doesn't pollute the Earth's atmosphere, exploit the poor or frighten the horses. But it has raised challenges that navigation professionals and their governments now seem unable to meet. **Professor David Last** walks us through the navigation... of navigation.

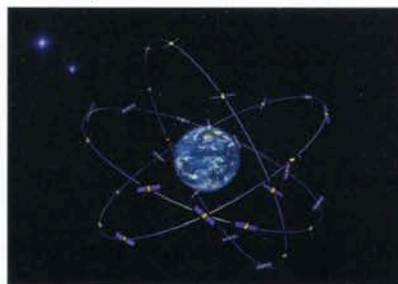
Life used to be so simple: practitioners of navigation were professionals. Most of them wore uniforms and many had beards. Some flew aircraft, others sailed ships and many drove land vehicles. Matching government departments administered their separate activities and helped achieve international cooperation and standardisation. But they remained apart: aviation technology was quite separate from marine buoys or traffic lights.

God was in his Heaven and all was well - until along came satellite navigation and spoiled it! Soon, this single new technology served navigators across all modes of transport. And not just navigators, from whom it escaped rapidly; it became a tool for many professions, and then, heaven forbid, a consumer product. Within a decade it had developed into the utility we know and love. A recent Royal Academy of Engineering study struggled to find a single area of transportation, commerce, industry or telecommunications in Britain that does not now employ satellite navigation.

Around the world, national governments with their separate ministries for modes of transport, plus industry, trade or communications were quite unprepared to respond to this single technology, on which depended activities as diverse as missiles and the stock market. No-one was responsible for

setting national policy in navigation: there was no clear plan for the navigation of navigation!

Yet leadership was essential: this intruder into national critical infrastructures was controlled not only by a foreign power, but by its military!



*Wait a minute...who owns this stuff? Credit:ESA*

## The Rise of the GPS-Wannabe

In response, those countries or regions that could afford to do so set up their own satellite navigation systems. Thus GPS begat GLONASS and Galileo and BeiDou, plus QZSS and IRNSS. They were supported by a host of augmentation systems: WAAS, EGNOS and other curious names. These new Global Navigation Satellite Systems (GNSS) soon became invested with great national or regional pride. Their immense cost had to be justified by claims of technical superiority. In

reality, their designers had no choice but to make them compatible with GPS, given that it had established itself as the world standard over decades. And the new systems had to squeeze into the few narrow radio frequency bands allocated to navigation. Not surprisingly, all our GNSS turned out to be very like GPS, essentially versions of the same technology - with just a hint of garlic here, a whiff of curry there. This similarity is obvious to engineers and navigators, though rarely to politicians.

For its first decade, GPS was seen as the way to meet almost all significant navigation needs, replacing other aids to navigation across land, sea and air. That was the clear view of the Government Accountability Office in the US, strongly supported in a historical RIN debate in 1991. And why not? The growth of GPS did indeed result in the demise of Decca Navigator, Omega, Datatrak and a host of national systems that simply could not compete technically or commercially. This success of satellite navigation led to certain hubris.

## A Series of Unfortunate Events

A series of unexpected events began to shake confidence: a major satellite failure causing serious position errors across Europe; an exceptional solar noise event severely impacting operation in the US; unintentional

radio interference denying satellite navigation across maritime areas and impacting mobile phone services; jamming attacks that threatened national infrastructure in the Far East. It became clear that relatively minor losses of service could affect huge numbers of users across the most diverse applications. In the US, growing concern among navigation professionals resulted in a rapid rise in the number of studies of GPS vulnerability. They showed that a solar event globally, or a small jammer locally, could seriously impact the use of GPS and its augmentations by all users across the areas affected. In 2001 the *Volpe Report* of the US Department of Transportation officially recognised the multiple threats to the USA posed by the vulnerability of GPS.



*We are the Men With Beards - navigational defenders. - Credit: istockphoto.com/arnphoto*

One outcome was a study led by the Federal Aviation Administration that resulted in the concept of Enhanced Loran (eLoran). This applied techniques developed for GPS to the widely-deployed, but obsolete, Loran C low-frequency terrestrial technology. The FAA showed that the resulting system could meet the accuracy, integrity, availability and continuity standards of certain aircraft instrument approaches plus the demanding harbour entrance requirements for ships. It could also deliver timing of an exceptionally high quality to support telecommunications networks. A high-level study group led by Professor Bradford Parkinson of GPS fame, with senior industry and government members, concluded that eLoran was the only cost-effective substitute for US needs. Its adoption as a national back-up to GPS was announced.

**The Tragedy of the Commons**

But the government of the US, although the leading nation in satellite navigation, turned out to be no better organised to handle a navigation system that benefitted multiple areas of national life than any other government. There too, the navigation of navigation went off course! Military GPS was no problem: the US Air Force alone handled that. But no single department owned either civil GPS, or this powerful potential back-

up – and each of them feared being landed with the bill for a service that benefitted all. Some call this dilemma the ‘Tragedy of the Commons’. And before it could be solved, a budget cut closed down the obsolete Loran C system, thereby removing the facilities recently modernised in preparation for the move to eLoran!

Other nations tempted to condemn this lack of US strategic vision should first question their own navigation plans. Have they even recognised, as the US had by 2001, their widespread dependence on vulnerable satellite navigation? Are they actually planning a response across all modes of application? And can European nations face the truth that Galileo, still struggling to reach fruition, is vulnerable to the same threats as GPS, both natural and man-made? There are jammers on the street ready to block Galileo’s Open and governmental PRS services. Nor are GLONASS, BeiDou, QZSS or any of the augmentation systems immune. Compatible satellite systems share common vulnerabilities! We need a complementary system that is wholly independent of GNSS, yet compatible with it. That is precisely what eLoran offered.



*From stock markets... Credit: istockphoto.com/mdpnboto*

**Flying Without A Net**

In the US, most Loran infrastructure, sites and towers, was mothballed. Now, after a period of inaction, the programme appears to be springing back to life with a Congressional mandate that the towers – essential for eLoran’s development - must be preserved. There is a lively discussion concerning operation by a non-government entity, driven initially by the needs of the telecoms industry.

And Europe? The UK and Ireland took the US eLoran concept and drove it forward. They have created a prototype system by re-using obsolete Loran C infrastructure from Northern Norway to Southern France, and adding their own low-cost station. For three years this has demonstrated that eLoran could meet the demanding maritime and telecommunications standards, as the FAA predicted. The prototype system has now achieved Initial Operational Capability in the Dover Strait, the world’s busiest maritime

choke-point. Shipborne equipment can switch automatically and seamlessly to eLoran when GPS is lost. Separately, a high-precision version of the technology for use by maritime pilots has been developed in the Port of Rotterdam. Russia is pursuing a related strategy, as is South Korea in response to its belligerent neighbour.



*...to Weapons of Mass Destruction... Credit: istockphoto.com/LOUATES*

Excellent news! At last Europe has followed the US by recognising the vulnerability of GNSS and has adopted an insurance policy, a working fall-back. Well, hardly! From top to bottom, Europe lacks any plan for the navigation of navigation. The European Commission declines to develop its proposed *European Radionavigation Plan* – who needs that when we have Galileo?! No single European country has a clear national policy that recognises the reality of GNSS vulnerability and plans to counter it. There has never been a European *Volpe Report*. There is simply no informed debate on the matter. Sadly, the vision of a robust combination of GNSS supported by a simple secure back-up looks likely to prove too bold for those responsible for the navigation of navigation in Europe.



*...and keeping the lights on - GNSS is about much more than getting you lost down a country lane. Credit: istockphoto.com/pelvidge*

We navigation professionals are indeed the stewards of a remarkable technology with great scope for further development. But until we and our governments honestly recognise its imperfections and make sensible plans to cope with them, it will fall far short of its full potential.