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The impact of GPS spoofing and jamming on aviation

The risk implications of aircraft navigation system interference

By
John Wadhams (https://www.wtwco.com/en-au/insights/all-insights#sort=%40fdate13762%20descending&f:@authors=[John%20Wadhams]) **|**
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Aviation has suffered a significant rise in GPS spoofing and jamming as geopolitical tensions have risen. How serious a risk is it?

The Soviet Union launched the Sputnik satellite, the first man made object to successfully orbit the earth, on October 4, 1957. As it made its way through the heavens, it emitted a radio signal which lasted for three weeks before the satellite's internal batteries died.

The world's scientists were listening. A team at John Hopkins University in the US picked up the radio signals and noted that they got stronger and weaker depending on the location of Sputnik. Using their understanding of the Doppler effect, discovered a century earlier, the scientists were able to correctly locate the satellite's position.

This led to a realization that if a satellite sending radio signals from space could be located from the ground, then a receiver on the ground could also be located via signals from space. The concept behind Global Navigation Satellite Systems (GNSS) was born.

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By 1968 a constellation of 36 satellites was being used to significantly improve the accuracy of maps and enhance navigation for the US Navy. The current Global Positioning System (GPS) was put in place in 1996, and has become synonymous with GNSS as a whole. GPS and GNSS more widely now have a broad array of civilian functions alongside its military applications, from helping people use their smartphones to find their way around, to ensuring that airline crews know where they are as they move across the Earth's expanses.[1]

What is GPS spoofing and jamming?

Some countries are reticent to rely on US information for their location data, so there are several other GNSS currently operating in parallel with the American developed GPS, including China's BeiDou, the European Union's Galileo and Russia's GLONASS. All four were initially developed for military use and each have their own radio frequency. India and Japan have also developed GPS alternatives although these are local rather than global services.[2]

There is an issue though. Some militaries are using technologies that disrupt GPS signals as a defence mechanism to reduce the effectiveness of hostile attacks from weaponry that relies on satellites to confirm their location. There's a simple logic to this: If you confuse a piece of military hardware about its location, it is less likely to hit its target.

The disruptive technologies broadly work in one of two ways: they either spoof the GPS signal or they jam it. Spoofing creates a false signal to suggest a receiver is somewhere it is not, whereas jamming emits signals that overpower the weaker satellite signals and stops location data reaching the receiver or renders it unintelligible. Because the satellites tend to be very far away, GNSS signals tend to be quite weak, making them susceptible to being overpowered by a nearer signal source.

Jamming is not generally very sophisticated as it simply overwhelms systems, and if a system can ascertain that it is being jammed, it can move to secondary system to ensure that it has the correct location.

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By contrast, spoofing releases a simulated GPS signal that appears legitimate and can trick a piece of hardware into thinking it is somewhere it is not or going in the wrong direction, which is complicated and requires sophisticated technology. If a system is being spoofed effectively, it might not recognise that it has a problem until it has missed its target.

Navigational threats in civil aviation

The problem is that modern civilian aircraft use GPS signals and spoofing and jamming technologies are indiscriminate: they simply override any signal passing through the area where they are operating. This means that civilian aircraft location systems are open to either being spoofed or jammed, particularly if they are operating near a contested location.

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Many aircraft systems interact with GPS and other GNSS. It might not matter too much if the rolling maps on a passenger's information screen aren't correct, but a problem with the EGPWS (Enhanced Ground Proximity Warning System) terrain avoiding safety system is potentially more significant. If these systems don't know where the aircraft is located, they might sound false alarms and encourage pilots to take avoidance action that puts an aircraft into danger.

Vigilance and training: business as usual

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This could be less of an issue than it first appears though: while autopilot systems take a lot of the workload off a pilot during normal operations, aircraft crew are trained to remain vigilant in the cockpit, and are likely to quickly notice the subtle clues that their flight is being spoofed such as if their aircraft makes a turn to follow a false signal or if the internal clocks change time.

Crews monitor the flight path of an aircraft constantly and in several ways, so if GPS data is unreliable they can switch to other navigation systems. These include the Inertial Reference System (IRS) which does not need external input to know where it is on the Earth. Data is calculated before take-off to determine its location using the planet's rotation (15 degrees per hour) relative to the aircraft in its stationary position, and from this start point a combination of lasers, gyroscopes and accelerometers maintains the aircraft's heading relative to True North.[3]

A growing problem

There has been much discussion recently around the risk that spoofing and jamming could pose to the aviation sector[4]. In some ways this reflects the fact that GNSS were not as ubiquitous to most people's daily life during the last comparable period of geopolitical turmoil in the early to mid-1990s.

The International Air Transport Association (IATA), the European Union Aviation Safety Agency (EASA) and other industry bodies are openly discussing the challenges the industry faces and holding workshops[5] to share best-practice as appropriate. Safety bulletins have also been issued for operations in areas where spoofing and jamming are known to have occurred. Reporting procedures are in place to ensure that knowledge of where incidents are happening is shared throughout the industry.

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From a risk perspective, spoofing and jamming have become a genuine threat at a time of heightened tension. The potential for an incident is real and significant, but it also well understood, crews are trained to spot and react to potential interference, and efficient countermeasures are being developed. At this point it is a concern rather than an issue and is being discussed at renewal, particularly with airlines that operate near geopolitical hotspots.

Technology moves quickly and the aviation industry is working with its partners to reduce the potential threat that spoofing and jamming represents. Projects are already being tested in public[6] that have the potential to reduce the risk, and the insurance industry will continue to work with everyone involved in the interest of enhancing safety.

WTW clients that would like to enhance their understanding of the insurance impactions of spoofing or jamming can log on to our online knowledge platform, Clarity on Demand (https://www.wtwco.com/en-au/solutions/products/clarity-on-demand) to learn more.

Footnotes

1. A Pilot's Guide To The Role Of GPS In Aviation A Pilot's Guide To The Role Of GPS In Aviation. (https://simpleflying.com/gps-in-aviation-pilots-guide/) Return to article ↩
2. Could the world cope if GPS stopped working? (https://www.bbc.co.uk/news/business-49985957) Return to article ↩
3. How electronic warfare is affecting civilians and aviation. (https://abcnews.go.com/US/electronic-warfare-affecting-civilians-aviation/story?id=109895516) Return to article ↩
4. How GPS warfare is playing havoc with civilian life. (https://www.ft.com/content/be9393db-cd63-4141-a4c8-c16b4fe1b6b0) Return to article ↩
5. EASA Partners with IATA to Counter Safety Threat from GNSS Spoofing & Jamming. (https://www.iata.org/en/pressroom/2024-releases/2024-01-26-01/) Return to article ↩
6. Unjammable navigation tech gets first airborne tes. (https://www.bbc.co.uk/news/articles/cz744gpl1dpo) Return to article ↩

Author

John Wadhams (https://www.wtwco.com/en-au/insights/all-insights#sort=%40fdate13762%20descending&f:@authors=[John%20Wadhams])
Managing Director, Client Relationship Management
WTW

Email (mailto:johnny.wadhams@wtwco.com) **+44 7880 770602** (tel:+44 7880 770602)

Contact

Pat Doherty
CEO, Australasian Aviation Division

Email (mailto:pat.doherty@wtwco.com) **+61 2 9285 4013** (tel:+61 2 9285 4013)

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