EXCLUSIVE CIO JOURNAL

The Secret to Better Airplane Navigation Could Be Inside the Earth's Crust

With GPS increasingly vulnerable to tampering, planes need more reliable navigation systems. The magnetic pull in the Earth's crust could offer a novel solution.

By Isabelle Bousquette Follow

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Acubed, Airbus's Silicon Valley-based innovation center, used a Beechcraft Baron aircraft in its large-scale test of SandboxAQ's quantum-sensing device. PHOTO: ACUBED

Satellite-based global positioning systems, or GPS, have been the primary method of aerospace navigation for decades. But with GPS jamming and spoofing on the rise, the industry is pushing for an update, and fast.

Now, Airbus's Silicon Valley-based innovation center, Acubed, and artificial intelligence and quantum-focused Google spinout SandboxAQ are on a mission to demonstrate an alternate way. It involves a small, toaster-size box, lasers, a single GPU chip and a deep knowledge of the Earth's magnetic field.

The technology, known as quantum sensing, has been in development for decades at a number of companies and is now inching closer to commercialization in aerospace.

SandboxAQ's MagNav quantum-sensing device.
PHOTO: SANDBOXAQ

Acubed recently took MagNav, SandboxAQ's quantum-sensing device, on a large-scale test, flying with it for more than 150 hours across the continental U.S. on a general aviation aircraft that Acubed calls its "flight lab."

MagNav uses quantum physics to measure the unique magnetic signatures at various points in the Earth's crust. An AI algorithm matches those signatures to an exact location. During the test, Acubed found it could be a promising alternative to GPS in its ability to determine the plane's location throughout the flights.

"The hard part was proving that the technology could work," said SandboxAQ Chief Executive Jack Hidary, adding that more testing and certifications will be required before the technology makes it out of the testing phase. SandboxAQ will target defense customers first but then also commercial flights, as a rise in GPS tampering makes the need for a backup navigation system on flights more urgent.

Airbus said it couldn't comment on future plans around using the technology. "I'm happy that we've been able to invest so far in this," said Eric Euteneuer, principal systems engineer at Acubed. "I think that it really shows that this technology can be a potential aid," he said. "The need for this encompasses all of Airbus's key business segments."

So-called GPS jamming, when geopositioning signals are blocked so a flight location isn't shown, and spoofing, when a GPS shows a false location, are on the rise in the Middle East and around Ukraine and Russia. Various militaries in the region might use such techniques to keep missiles and drones from finding their targets, but the practice can impact civilian flights.

GPS vs. quantum sensing

GPS works by broadcasting precise signals from a constellation of satellites that circle the globe. But militaries and bad actors can also send out fake signals, broadcast from the ground, that are hard to distinguish.

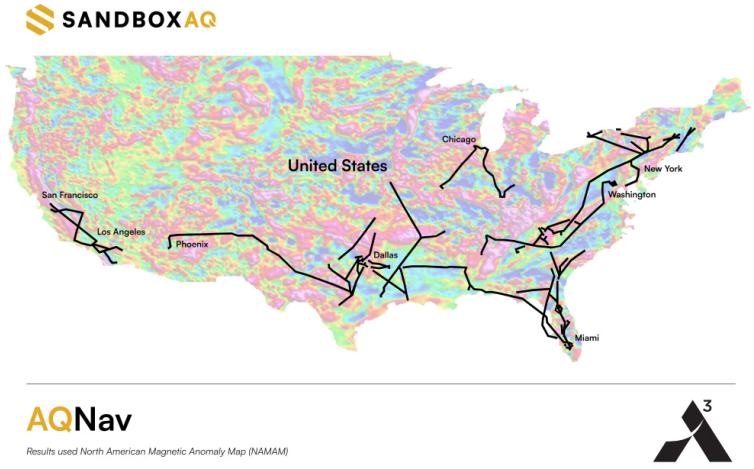
The quantum sensing device is completely analog, making it essentially unjammable and unspoofable, SandboxAQ's Hidary said. Unlike GPS, it doesn't rely on any digital signals that are vulnerable to hacking. The information it provides is generated entirely from the device on board, and leverages magnetic signatures from the Earth, which cannot be faked, he said.

Quantum sensing will likely not replace all the applications of traditional GPS, but it can be a reliable backup and help pilots actually know when GPS is being spoofed, Hidary said.

How it works

Inside SandboxAQ's device, essentially a small black box, a laser fires a photon at an electron, forcing it to absorb that photon. When the laser turns off, that electron goes back to its ground state, and releases the photon. As the photon is released, it gives off a unique signature based on the strength of the Earth's magnetic field at that particular location.

Every square meter of the world has a unique magnetic signature based on the specific way charged iron particles in the Earth's molten outer core magnetize the minerals in its crust. SandboxAQ's device tracks that signature, feeds it into an AI algorithm that runs on a single GPU, compares the signature to existing magnetic signature maps, and returns an exact location.



The flight paths used in the tests of SandboxAQ's quantum-sensing device, MagNav. ILLUSTRATION: SANDBOXAQ

The Federal Aviation Administration requires that while planes are en route they

must be able to pinpoint their exact location within 2 nautical miles (slightly more than 2 miles). During Acubed's testing, it found that MagNav could pinpoint location within 2 nautical miles 100% of the time, and could even pinpoint location within 550 meters, or a bit more than a quarter of a nautical mile, 64% of the time.

"It's the first novel absolute navigation system to our knowledge in the last 50 years," Hidary said.

What else can quantum sensing do?

EY's Global Chief Innovation Officer Joe Depa said the applications for quantum sensing go beyond aerospace. In defense, they can also be used to detect hidden submarines and tunnels.

And in healthcare, they can even detect faint magnetic signals from the brain or heart, theoretically allowing for better diagnosis of neurological and cardiac conditions without invasive procedures.

While the technology has been in the lab for decades, we are starting to see more examples of quantum sensing entering the real world, Depa said.

Some analysts estimate the quantum-sensing market could reach between $1 billion and $6 billion by 2040, he said.

"We're not talking about something 20 years out," Depa said. "This is here and now."

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