

# The evolution of GPS: What to expect from global navigation satellite systems in the next 50 years

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More robust and more accurate positioning systems are needed to meet

the demands of the global economy—and Australia is set to enjoy the benefits of its very own system.

Global Positioning Systems turned 50 years old last year with the 'golden' anniversary of the US Air Force being given approval in 1973 to develop the Navstar GPS.

GPS has since become a vital component of everyday life that is largely taken for granted by the billions of people who use it for positioning, navigation and timing every single day.

But that increasing reliance also causes greater risks and experts are warning of the dangers if this important technology can be hacked, jammed or even knocked out completely by a natural disaster such as a huge geomagnetic storm.

That's why developments continue apace in the world of GPS—including Australia and New Zealand's very own multi-billion dollar positioning system called SouthPAN, which is already active and with more and more services set to be made available in the coming months and years.

The UNSW Australian Center for Space Engineering Research (ACSER) in partnership with the School of Civil and Environmental Engineering (CVEN) will soon host the International Global Navigation Satellite Systems (IGNSS) Conference to bring together experts, policy makers and tech leaders to discuss important topics concerning the industry.

Here, UNSW academics Professor Andrew Dempster and Dr. Craig Roberts give a sneak peek what people can expect from GPS over the next 50 years.

## Australasia gets its own 'GPS' system

What most people generally call GPS is actually a specific system owned by the United States government and now operated by the United States Space Force. It was started in 1973.

However, other countries have since developed their own systems and there are currently three major alternatives: Russia's GLONASS, China's BeiDou Navigation Satellite System, and the Galileo system developed by the European Union. Collectively they are called Global Navigation Satellite Systems (GNSS).

India and Japan have also been developing separate systems that are not global. Augmentation systems have been introduced by the US, Europe, Japan and others to overcome some GNSS shortcomings using [geostationary satellites](#) (satellites that are always in the same place in the sky).

Australia and New Zealand have now added themselves to the list by joining forces to launch the SouthPAN system—designed to meet global performance requirements under the region's unique service area and space weather conditions.

"SouthPAN is technically a satellite-based augmentation system, which means it is still relying on receiving signals from other [satellite systems](#) but then utilizes a number of ground stations to process all the data and then correct some of the errors, making it more accurate," says Prof. Dempster, director of ACSER.

"The stated aim is that by 2028 you will be able to use this system via your mobile phone and it will tell you within 10 centimeters exactly where you are."

In recent times uncorrected GPS signals in Australia have only been accurate to within around three to five meters.

The effect of SouthPAN, therefore, will be that every major industry across Australia and New Zealand, from transport and construction to resources and agriculture, will gain significant positioning and navigation benefits.

## **How GPS can continue to improve agriculture**

You may not know that global navigation satellite systems have become vital in the agricultural industry to reduce costs and improve yields.

GPS is used to plan farming areas, map farms and track the yields of crops from different locations, as well as helping farmers to work in more challenging conditions including even in darkness.

So making accurate GPS information even more accurate available and reliable over the next 50 years will only improve crop production.

"On a basic level it's good to know exactly where you are when you are a farmer in your combined harvester because you don't want to be inefficient and waste time or fuel, and also you don't want to drive over your crop and damage it," says Dr. Roberts from UNSW's School of Civil and Environmental Engineering.

"The more automated it is, via an accurate GPS system, the more productive the process as farmers can reduce fatigue.

"In addition, there is a lot of technical agricultural information that can be paired with the GPS data. For example, grain can be analyzed to show the exact protein levels and if you know precisely where that grain was harvested from you get some very useful knowledge.

"And they can do the same for soil moisture and fertilizer usage for each specific location which over time helps to maximize the yields."

## **The need for more robust security**

A huge number of technological systems would be affected if global positioning systems were hacked or jammed on a major scale—from airliners to electric grids, from stock markets to ATMs, and any other system that relies on GPS to time their operations.

Such events might be caused deliberately by bad actors in the geopolitical sphere, or by a natural phenomenon such as a geomagnetic storm. Many fear a repeat of the Carrington Event of 1859 would knock out every high level Earth-orbiting satellite in an instant by frying their electronics.

"The problem is that we're now wedded to GNSS and satellite positioning, but it's really vulnerable. The goal for the future is to keep utilizing the systems, but be less vulnerable," says Prof. Dempster.

"There have been studies done that show that every single sector of the economy that can be considered critical infrastructure, relies on GNSS. So many things need accurate positioning, or accurate timing.

"If you take out a major GPS system then there is an awful lot that can go wrong. But people are becoming more aware of the issue and resilience is becoming a bigger thing.

"There is a lot of work being done on the assumption that at some point a major GPS system will go down."

One solution is for navigation services to be provided by satellites in low-Earth orbits (LEO). These would sit at around 500–1,000km above the

Earth—as opposed to the current satellites which are around 20,000km high—and would therefore be more protected by the Earth's own atmosphere should significant geomagnetic activity from space occur.

Another benefit is the signals are 20 times stronger than traditional GPS systems, although the low orbit means that each satellite's antenna covers a smaller radius of the Earth's surface and so more of them are required to provide the same coverage.

"When those signals are more robust from satellites in LEO there are a few benefits," explains Dr. Roberts.

"Firstly, the signals become harder to jam or spoof and so there is an extra layer of security.

"The second is that emergency services may be able to benefit more from more robust positioning systems. When signals have to travel 20,000km up and down from Earth, they get can be very weak, and that is why GPS does not really work indoors.

"But with new systems with closer satellites and much stronger signals, the potential for accurate GPS inside of buildings increases and there are possible important applications there for those involved with search and rescue."

Provided by University of New South Wales

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