Questions & Answers **[1]**

Has GPS been used differently in the present day than when it was first invented? How has GPS improved over the decades?

Hi Tommy, the first GPS satellites were used by the military and there were just five satellites. Ships in the US Navy could fix their position only once per hour. The system wasn't used by the public until 1995 when a network of 21 satellites was finished. Today's GPS network has around 30 active satellites in the GPS constellation.

Today, GPS is used for dozens of navigation applications, route finding for drivers, map-making, earthquake research, climate studies, and an outdoor treasure-hunting game known as geocaching.

From Shelley the LEARNZ teacher.

Could the GPS system be hacked and taken over/shut down? What would happen? How would it be restarted? And what security measures are in place to make sure this doesn't happen?

Hi Ash, here is an answer from Dionne Hansen who is a Geodetic Surveyor with LINZ:

The GPS system was developed for USA military and originally the signal was artificially degraded civilian users. This was switched off in 2000. Technology has moved forward since then and the military use a different type of signal and receiver than what is available for everyone else. It is known as M-code, and much of the details about these signals are classified for security reasons. Security is very robust for all military navigation.

That said, the main types of threats to GPS are spoofing and jamming and affect the user’s GPS receiver rather than the satellites. Jamming is blocking or interfering with the GPS signal from the satellite to stop it from being received. This is relatively easy to do on the ground because the GPS signal is low energy and easily ‘drowned out’ by a stronger signal. Spoofing is simulating a GPS signal to tell a receiver that it’s in a different place from where it actually is. This is done to take control of the ‘vehicle’ and steer it off course, but spoofing is very complicated and there are easier ways of steering a vehicle off course than trying to confuse the GPS receiver. The military M-code signals are encrypted and cannot be spoofed, but they are still susceptible to jamming. A jammer can wipe out a large area to both military and civilian users.

The most common safe guards against ‘hacking’ are external independent ‘backup systems’ that are not linked with the GPS system and are not hackable because they have no connection to the outside world. These are also called ‘redundant

systems'.

The redundant systems include: backup atomic clocks to keep time, multi-GNSS receivers where different satellite systems can be used as verification, smart receivers that know where to 'listen' for GPS signals which signals to ignore so they can't be jammed. Inertial Navigation Systems (INS) are also used that have inertial sensors, accelerometers, and gyroscopes to confirm velocity and direction as a cross check for GPS.

There have been several independent studies into the 'hackability' of the different components of the GPS system in the past few years, vulnerabilities are identified and corrected. As a result, the most up to date satellites are less 'linked up' with the ground, so there are fewer links in the chain that could possibly fail and they are designed specifically to prevent jamming, eavesdropping and cyber-attacks. The ground stations also have increased and ever changing security measures to prevent attacks. There are attempts on the system every day, and security is only getting better, faster, and more automated.

It is difficult to say what the real consequences of a successful attack would be it depends on the intended purpose. The most critical services will have backup systems. It is likely that the civilian uses (like smart phones) solely reliant on one method of positioning would be most affected, but this will be less and less common as there are now multi-satellite system smart phones.

Dionne Hansen, Geodetic Suveryor for LINZ.

Do GPS's have a massive library to determine what town or city you are in, if not do they only give you latitude and longitude?

Hi Hugh, GPS is a global system of satellites (not a library) used to calculate an exact location given as co-ordinates of latitude and longitude. A receiver needs to get signals transmitted from at least 3-4 satellites and these are used to calculate location. You can find out more on the GPS background page: http://learnz.org.nz/location162/bg-standard-f/gps-global-positioning-systems [2]

From Shelley the LEARNZ field trip teacher.

With so much information coming in every second of everyday, where does all of this information go to and who controls it?

If you are talking about the CORS station which we visited at the Wellington Airport, which continuously records data about its position, then this is part of a network run by Land Information New Zealand and GNS Science. The information is shared between these organisations and recorded by computers. This information is used to make corrections to maps and find out how much the land is moving due to plate tectonics. Other stations in other countries would be controlled by other organisations such as NASA in the United States.

From Shelley the LEARNZ field trip teacher.

With so many planes in the sky and they are all using the latest GPS technology which pilots can fall asleep on, how did WW1 and WW2 planes navigate long distance with minimum GPS technology?

Planes did not used to have GPS technology and used aeronautical charts and maths to calculate their position - not as accurate especially when there wasn't good visibility. You can find out more about air navigation by reading this background page: http://learnz.org.nz/location162/bg-standard-f/air-navigation [3]

From Shelley the LEARNZ field trip teacher.

When you look at a map how do you know what layers there are?

Hi Nethidu, GIS or Geographic Information Systems are digital maps (maps on computers) that have different layers that can be turned on and off to show different information. A legend or key would tell you what layers are available and you can then select them depending on what you want to find out. For example you may want to find out information about where you live such as where the roads are, where the power lines are and where the water pipes are. This information would be shown in different layers. You can choose to show all or just some layers of information.

From Shelley the LEARNZ field trip teacher.

When GNS Science put the GPS on top of Aoraki/Mount Cook how come they couldn't just press go without taking any measurements? What had they done before hand?

Hi Maddy, the height of Mount Cook was re-measured in three different ways to make sure the height was accurate. GPS receivers had to be placed very close to the summit and then measured from a nearby station - GPS works by having signals transmitted and received - so you can't just have one receiver. You can find out more here: http://www.otago.ac.nz/surveying/research/geodetic/otago061558.html [4]

From Shelley the LEARNZ field trip teacher.

How are atomic clocks made and how do you know they remain accurate?

Hi Ben, well it's a bit complicated... atomic clocks are very accurate as they use the set rate at which atoms vibrate. The first quality atomic clocks made in the 1950s were based on cesium atoms, and such clocks have been made more accurate over the decades. These clocks are used to keep official time throughout the world. You can find out more at
http://www.livescience.com/32660-how-does-an-atomic-clock-work.html [5]

From Shelley the LEARNZ field trip teacher.

Source URL: https://www.learnz.org.nz/location162/questions-and-answers

Links
[1] https://www.learnz.org.nz/location162/questions-and-answers
[2] http://learnz.org.nz/location162/bg-standard-f/gps-global-positioning-systems
[3] http://learnz.org.nz/location162/bg-standard-f/air-navigation
[4] http://www.otago.ac.nz/surveying/research/geodetic/otago061558.html
[5] http://www.livescience.com/32660-how-does-an-atomic-clock-work.html