



## Global Positioning System

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**Global Positioning System**, or GPS is a highly sophisticated network of satellites and ground stations that can provide an almost instantaneous location anywhere on the surface of the earth. Even though GPS makes use of complex technology that is a mystery to most, being able to use it is easy. The following will provide some GPS background to help understand how the system works. After all, its very beneficial to know more about a system that makes finding your way easy. GPS has become omnipresent now that it's built in to almost every tablet and smart phone on the market.

- Some elements used by GPS were developed as early as the 1950's but the first satellite, called **NAVSTAR 1** (an acronym for Navigation Satellite Timing and Ranging), was launched in **1978**.
- **The beginning: Satellite navigation systems date back to 1960.** That was when Transit, used by the United States Navy, was first tested successfully. Transit used up to 10 satellites. The receivers judged their position based on the Doppler effect on the signals sent from the satellites. Modern systems like GPS work differently, relying heavily on exact timing, hence the use of atomic clocks in the GPS satellites.



- There are always at least **24 active GPS satellites circling Earth**, although today there are more than 30, including a couple spares. Their orbits are calculated so no matter where on Earth you are, you will have at least six of them in your line of sight.
- Each GPS satellite goes around the world **once every 12 hours**. The satellites travel **12,500 miles (20,000 km) above us** at roughly 7,000 miles per hour (11,000 km per hour). They have small boosters so they can adjust their path when needed.
- The first full constellation of 24 satellites was **completed in 1994**. The first of those 24 satellites was sent up in 1989.
- To get a reliable position reading, your GPS receiver has to combine signals from **at least four satellites**, although in some special cases, three are enough.
- GPS was made public due to a tragedy. In 1983, Korean Air Lines Flight 007 entered Soviet airspace after a navigation error and was shot down, killing all 269 passengers. This incident resulted in **President Ronald Reagan ordering the United States military to make the Global Positioning System available for civilian use** once it was completed, so that similar incidents could be avoided in the future.
- **NAVSTAR** is the US military name for the Global Positioning System.



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- **GPS isn't just for navigation.** It can also be used to get a very exact time stamp. Every GPS satellite has multiple atomic clocks and the time is included in the signal it sends out. With the help of these signals, a GPS receiver can determine the current time within 100 billionths of a second. These signals are used to synchronize base stations in cell phone networks.
- **Relativistic effects.** The clocks on the satellites, although very exact, are still subject to the effects of Einstein's theory of relativity, which means that the time of the clocks in the satellites will slowly start to deviate from those on Earth. This is adjusted by control signals from Earth.
- **Ground antennas spread around the world** are used to control the satellites' paths and synchronize their clocks.
- **The 50th Space Wing of the United States Air Force operates the GPS satellites.** GPS is owned and under the control of the United States Department of Defence.
- **Until 2000, civilian GPS use was altered by a feature called Selective Availability.** It introduced a random error of up to 328 feet (100 meters) in the civilian signal to make GPS less useful for precision navigation. (GPS has different signals for military and civilian use.) Selective Availability was deactivated in May 1, 2000. The United States still has the ability to deactivate the civilian signal, if need be for specific regions.
- **During the Gulf War in 1991,** many US soldiers were equipped with civilian GPS units due to a shortage of military ones. However, Selective Availability made it extremely difficult to properly coordinate troop movements with civilian GPS units, so it was turned off for the duration of the war.
- **GPS is a work in progress.** The system is continuously being upgraded and new satellites are being launched. This means precision will keep getting better, which will make the system increasingly useful.
- **GPS isn't the only game in town.** There are several other Global Navigation Satellite Systems in existence or on their way: The European Union is working on a system called Galileo, Russia has GLONASS (completed in partnership with India), and China has plans for a system called Compass. There are also systems that offer specific regional coverage, for example Japan's QZSS and China's Beidou.