

Navigation Now

Key Science Idea:

GPS - global positioning system
A satellite system used to give exact location on Earth in coordinates

Humans long ago went to pretty extreme measures to keep from getting lost. They erected monumental landmarks, drafted very detailed maps &/or learned to read hundreds of stars in the night sky.

Things are much, much easier today. For less than \$100, you can get a pocket-sized gadget that will tell you exactly where you are on Earth at any moment. However, for some, the Global Positioning System is vast, expensive and involves a lot of technical know-how.



ANCIENT POLYNESIAN LANDMARK AT EASTER ISLAND

Retrieved 1.31.06 from <http://en.wikipedia.org/wiki/Image:Easter-island-moai.jpg>



Photo courtesy
[Garmin](#)
**Garmin
GPS 72**

When people talk about "a GPS," they usually mean a **GPS receiver**. The **Global Positioning System** (GPS) is actually a constellation of 27 Earth-orbiting satellites (24 in operation and three extras in case one fails). The U.S. military created and used these satellites as a military navigation system, but soon opened it up to everybody else.

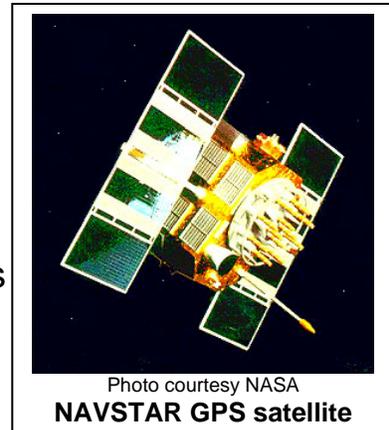


Photo courtesy NASA
NAVSTAR GPS satellite

How GPS Works

Each of these 3,000- to 4,000-pound solar-powered satellites circles the globe at about 12,000 miles (19,300 km), going completely around the Earth twice every day. The orbits are arranged so that at any time, anywhere on Earth, there are at least four satellites "visible" in the sky.

A GPS receiver's job is to locate four or more of these satellites, figure out the distance to each, and use this information to find its own location. This operation is based on a simple math principle called **trilateration**.

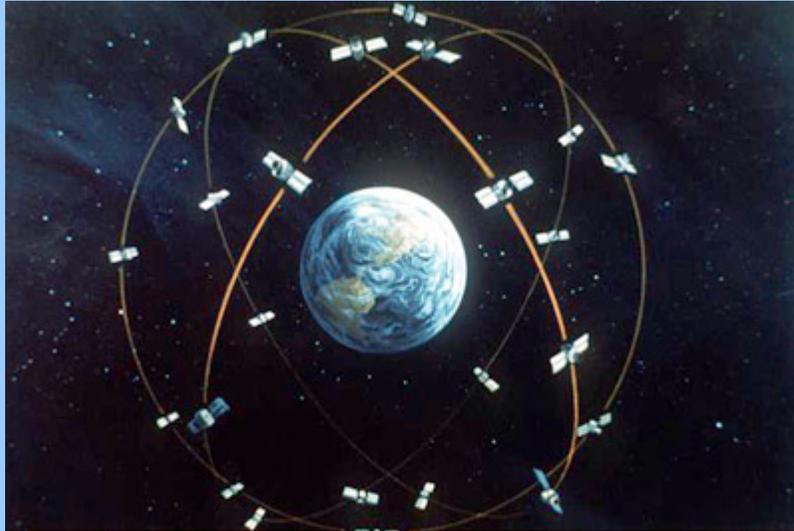
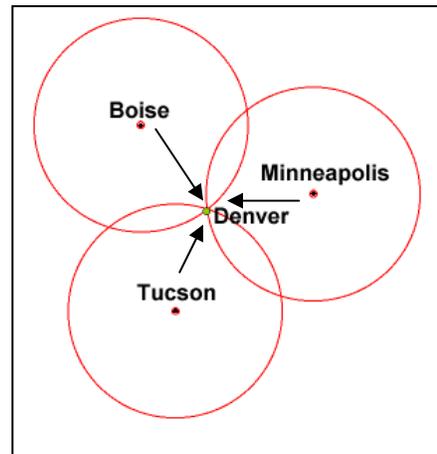


Photo courtesy [U.S. Department of Defense](#)

Artist's concept of the GPS satellite constellation

Trilateration works like this. Imagine you didn't know you were in Denver, and you asked 3 people in different cities how far away they were from you. If each person gave you *their* exact location and said how many miles away they were from *you*, you could **triangulate** your own location! This works with maps, because they're 2-D (flat).



GPS works the same way, but because the Earth is round, it has to figure out distances for 3-D. Instead of using 3 points of a flat triangle to figure it out, the GPS uses 4 points of a sphere! That's what trilateration is – simply triangulating distances onto the globe!

In order to make this simple calculation, the GPS receiver has to know two things:

- The location of at least three satellites above you
- The distance between you and each of those satellites

The GPS receiver figures both of these things out by analyzing high-frequency, low-power **radio signals** from the satellites. Radio waves are electromagnetic energy, which means they travel at the speed of light (about 186,000 miles/second). The receiver can figure out how far the signal has traveled by timing how long it took the signal to arrive. That's how *it* finds *you* & you find your way!

