Locating Positions Using GPS

Calculating a position on Earth's surface requires measuring the exact distance from a GPS receiver on Earth's surface to GPS satellites in space. This is particularly challenging because the satellites are rapidly orbiting Earth approximately 11,000 miles above Earth's surface. The basis of GPS is similar to the concept of trilateration. To understand this concept, let's pretend that a person is trying to locate him/herself using GPS satellites.

The distance from a GPS satellite in space to a GPS receiver on Earth's surface can be calculated using the equation for velocity. Once the distance is known, data from three satellites are needed to determine a position.

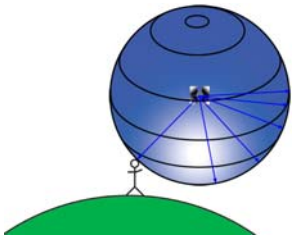
VELOCITY = **DISTANCE** ÷ **TIME**

Known: The radio waves being emitted from the GPS satellite travel at the speed of light (186,000 miles per second).

Known: The GPS receiver measures the time it takes for the radio signal to travel from the satellite to the receiver.

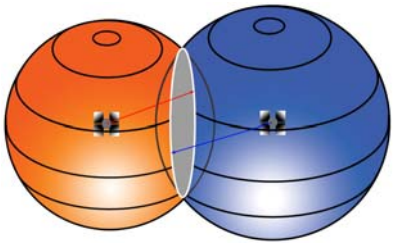
Using data from one satellite

Left: The person is located a certain distance, represented by the blue arrow, from the satellite.
Right: That means that his/her position could be anywhere on the surface of an imaginary, hollow sphere, represented in blue, whose center is the satellite and whose radius is the blue arrow. A more specific position description is needed to find the person's location. To obtain this position, a second satellite is used.



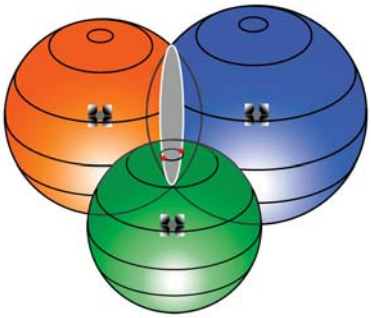
Using data from two satellites

If the person is also located a certain distance, represented by the red arrow, from the second satellite, that means that his/her position is also located someplace on the surface of an imaginary, hollow sphere, represented in orange, whose center is the second satellite and whose radius is the red arrow. With data from two satellites, the person's position lies someplace where the two spheres intersect.
The intersection of the two spheres is a circle, which is represented by the white line in the diagram. He/she must be located someplace on that circle, but a more specific position description is needed to find the person's position. To obtain a more specific position, a third satellite is used.



Using data from three satellites

If the person is also located a certain distance from the third satellite, that means that his/her position is also located someplace on the surface of an imaginary, hollow sphere represented in green. With data from three satellites, the person's position lies someplace where the three spheres intersect. They intersect at two points, which are represented by the red dots in the diagram. One of these two points is the person's position on Earth's surface. Typically, one of the two points can be rejected because it does not lie on Earth's surface. (For example, the point may be located inside the Earth.) Alternatively, using data from a fourth satellite will narrow his/her location down to one point.



Diagrams are not drawn to scale. Modified from Trimble.