What is GPS?

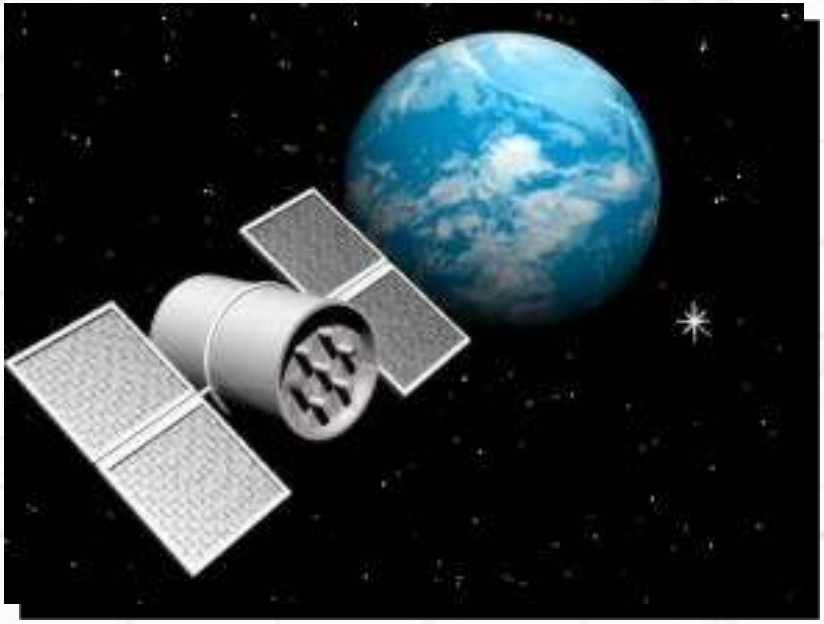
GPS, which stands for Global Positioning System, is the only system today able to show you your exact position on the Earth anytime, in any weather, anywhere.

The three parts of GPS are:

- Satellites
- Receivers
- Software

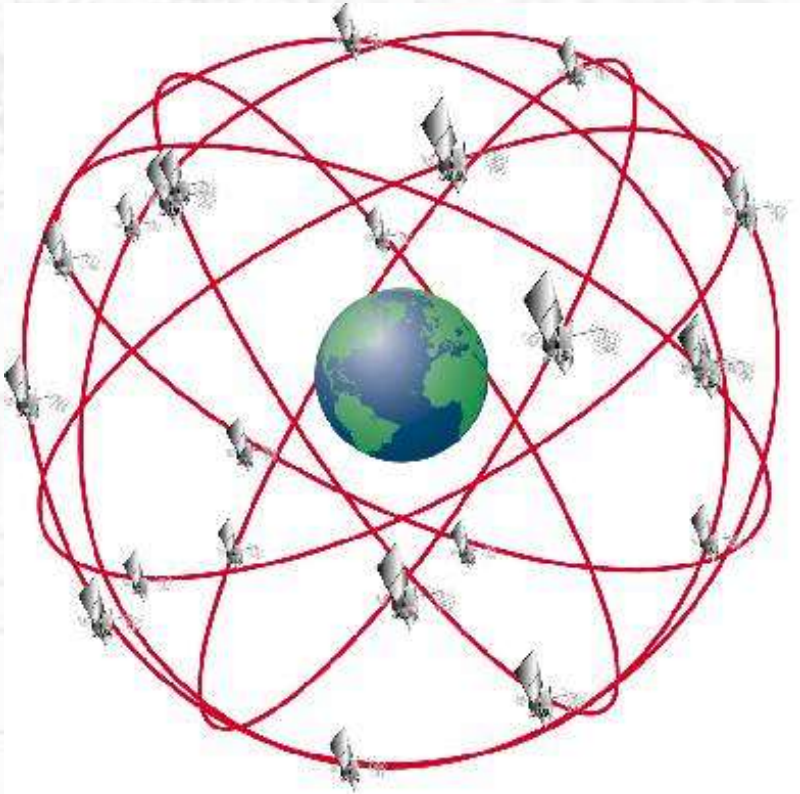
Satellites

There are quite a number of satellites out there in space. They are used for a wide range of purposes: satellite TV, cellular phones, military purposes and etc. Satellites can also be used by GPS receivers.



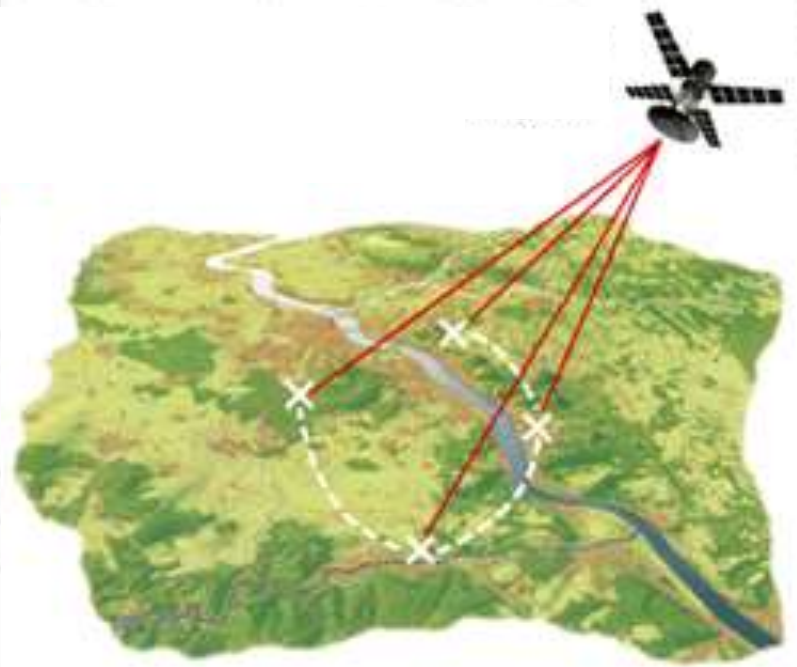
GPS Satellites

The GPS Operational Constellation consists of 24 satellites that orbit the Earth in very precise orbits twice a day. GPS satellites emit continuous navigation signals.



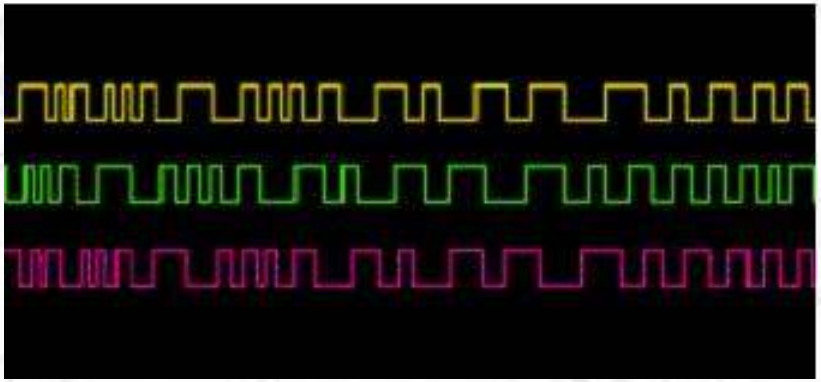
Receivers and Satellites

GPS units are made to communicate with GPS satellites (which have a much better view of the Earth) to find out exactly where they are on the global scale of things.



GPS Signals

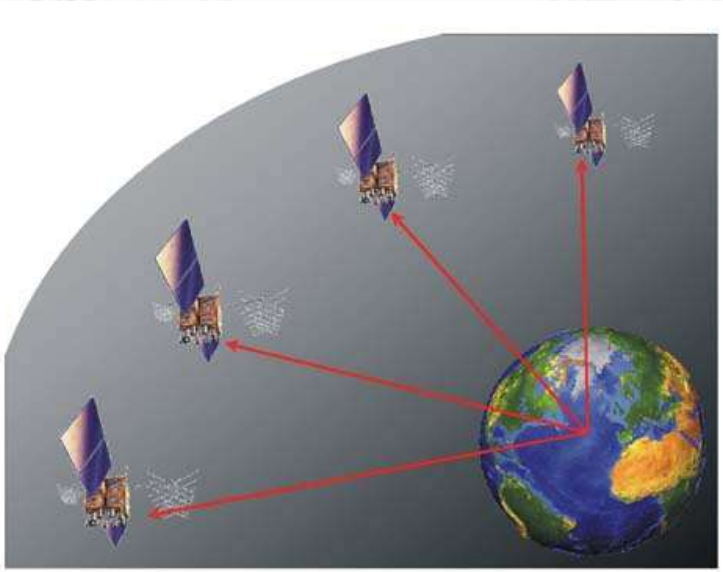
Each GPS satellite transmits data that indicates its location and the current time. All GPS satellites synchronize operations so that these repeating signals are transmitted at the same instant.



Physically the signal is just a complicated digital code, or in other words, a complicated sequence of “on” and “off” pulses.

Time Difference

The GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is.



Calculating Distance

Velocity x Time = Distance

Radio waves travel at the speed of light, roughly 186,000 miles per second (mps)

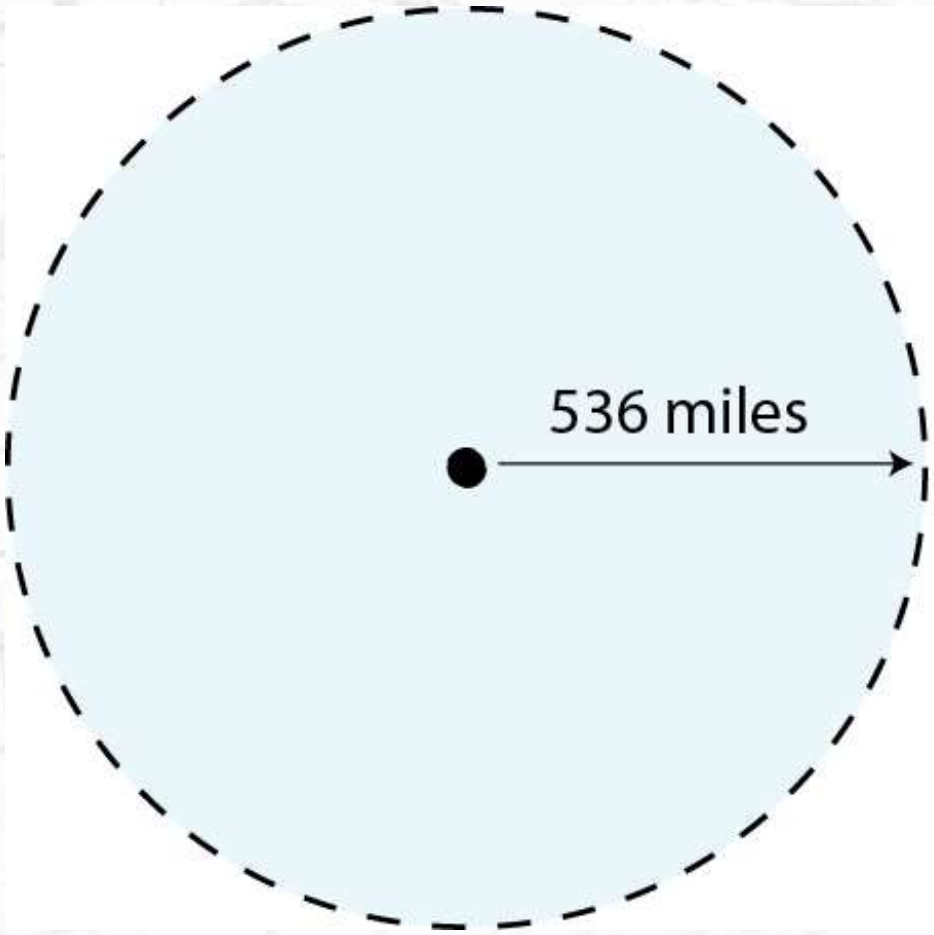
If it took 0.06 seconds to receive a signal transmitted by a satellite floating directly overhead, use this formula to find your distance from the satellite.

186,000 mps **x 0.06** seconds **= 11,160 miles**

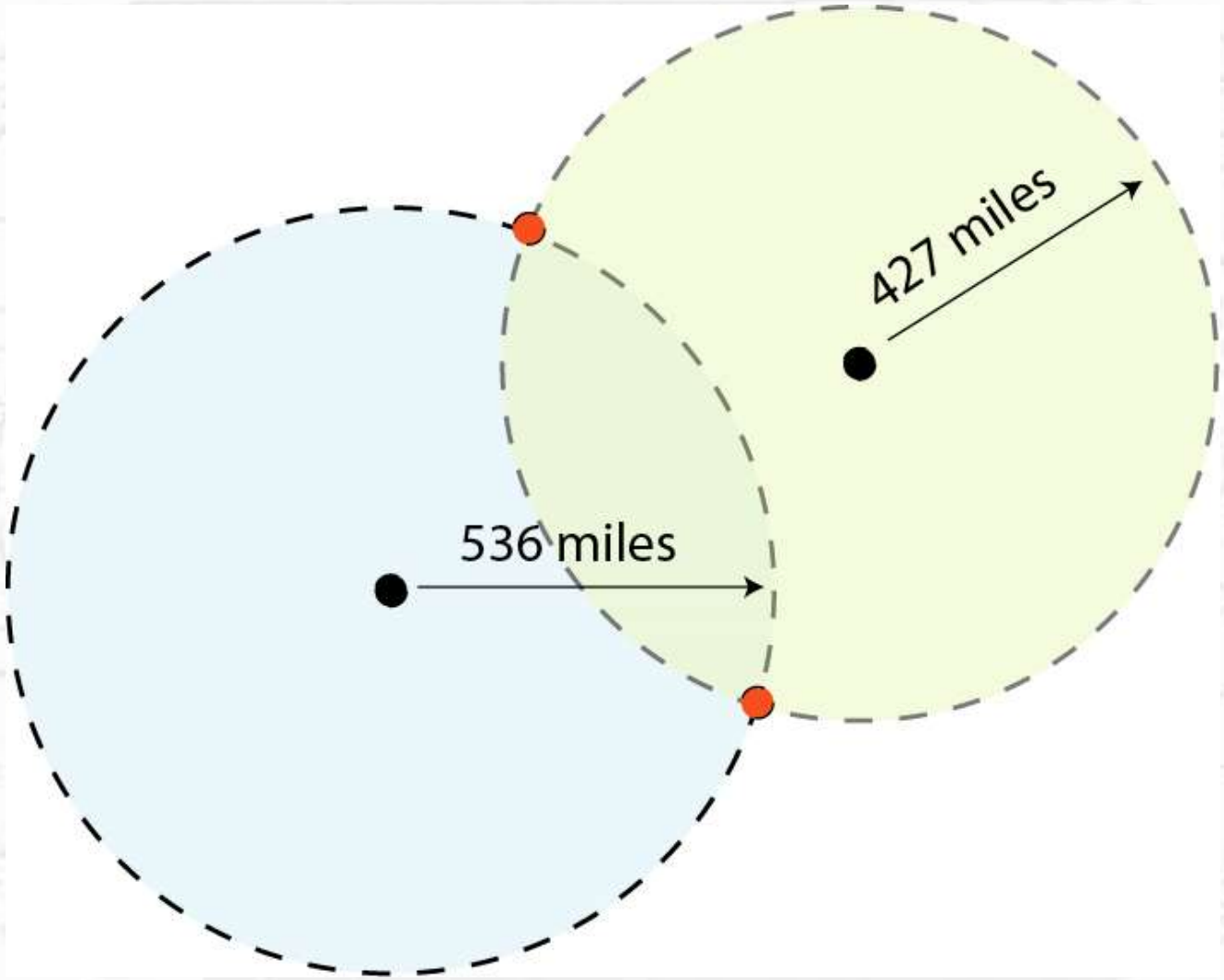
Triangulation

Geometric Principle:

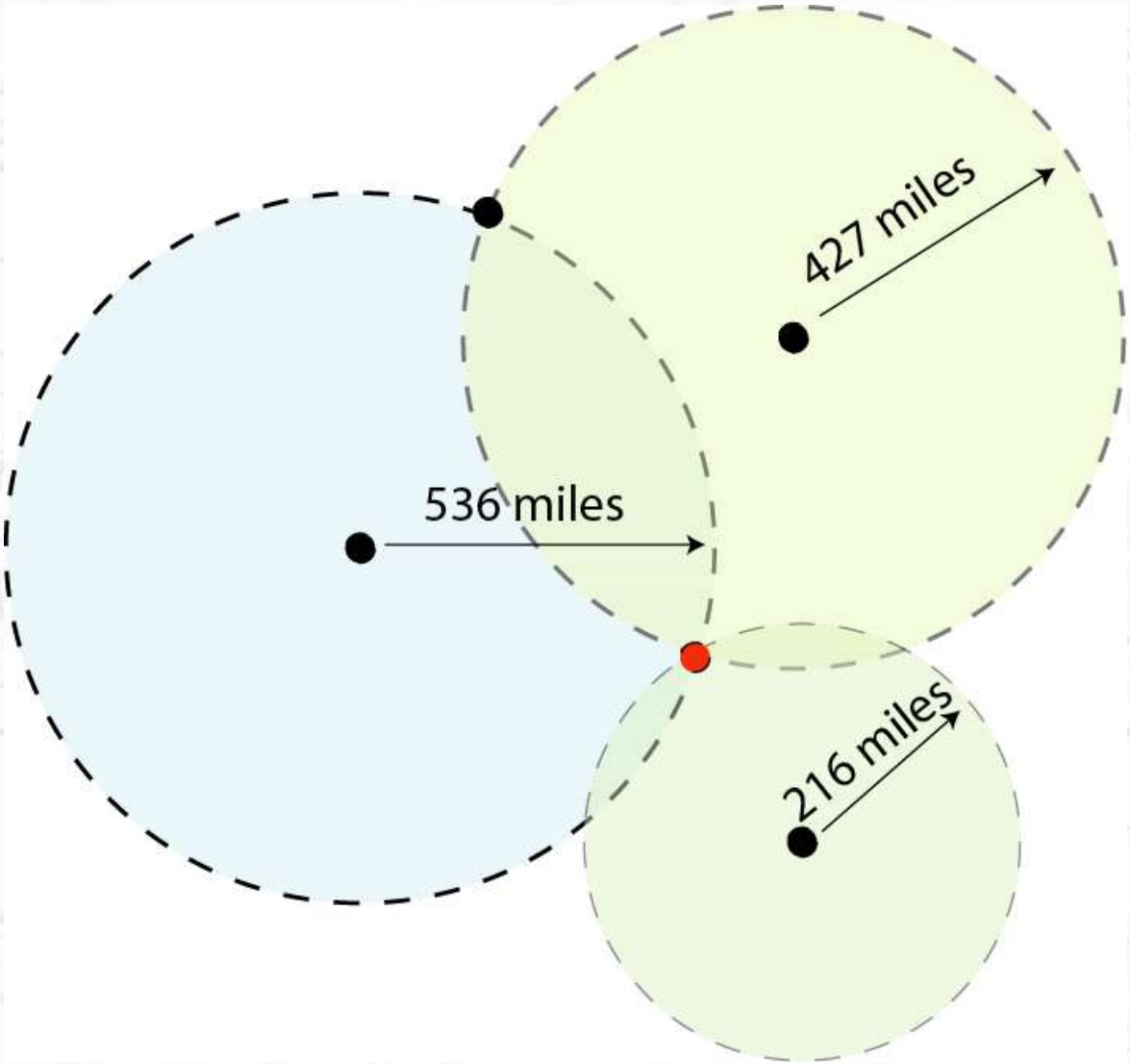
You can find one location if you know its distance from other, already-known locations.



Triangulation

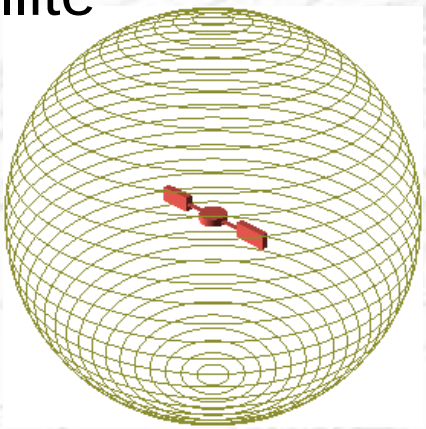


Triangulation

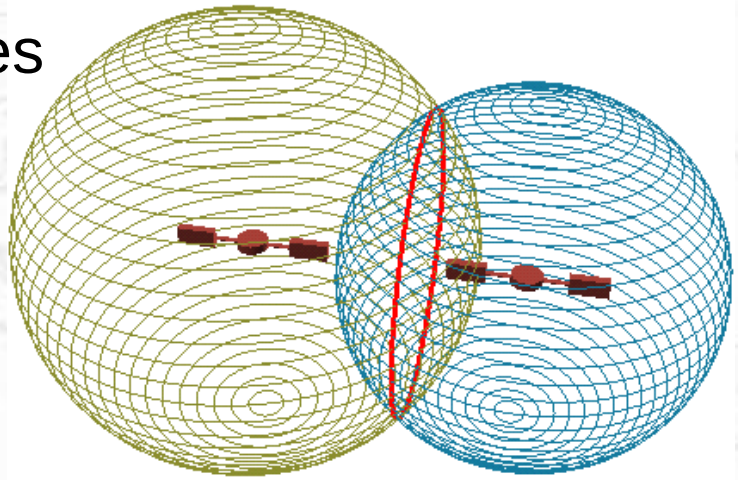


3-D Trilateration

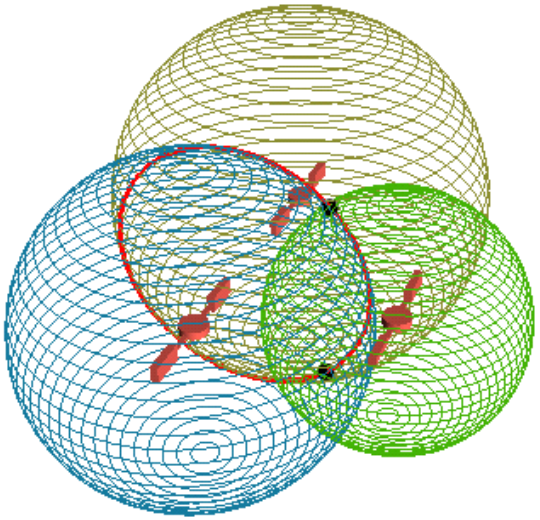
1 Satellite

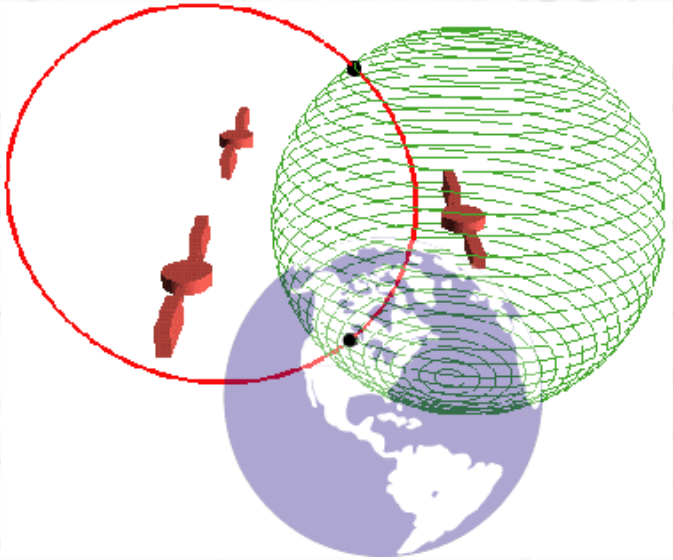


2 Satellites



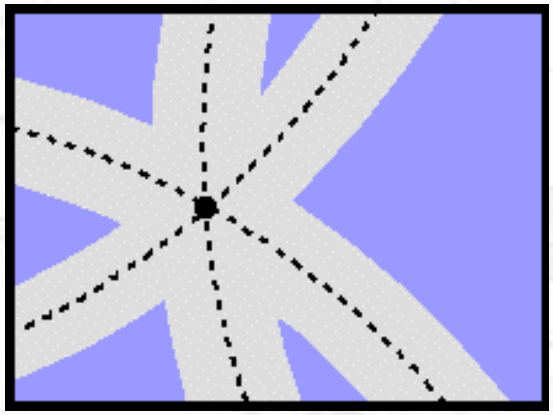
3 Satellites

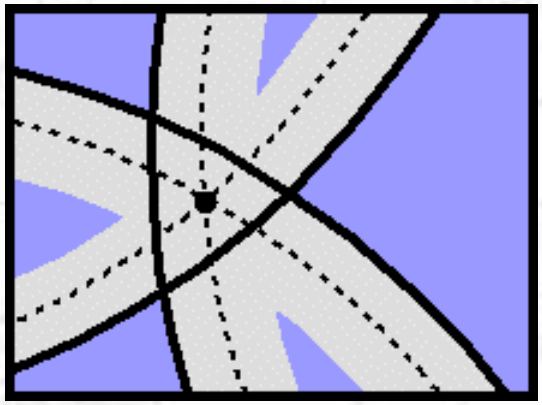


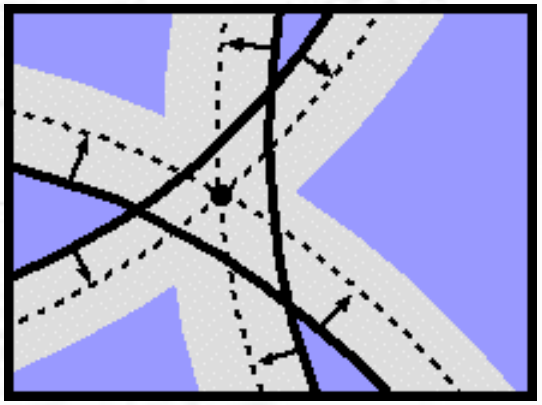


Atomic Clocks

GPS satellites use Atomic Clocks for accuracy, but because of the expense, most GPS receivers do not.

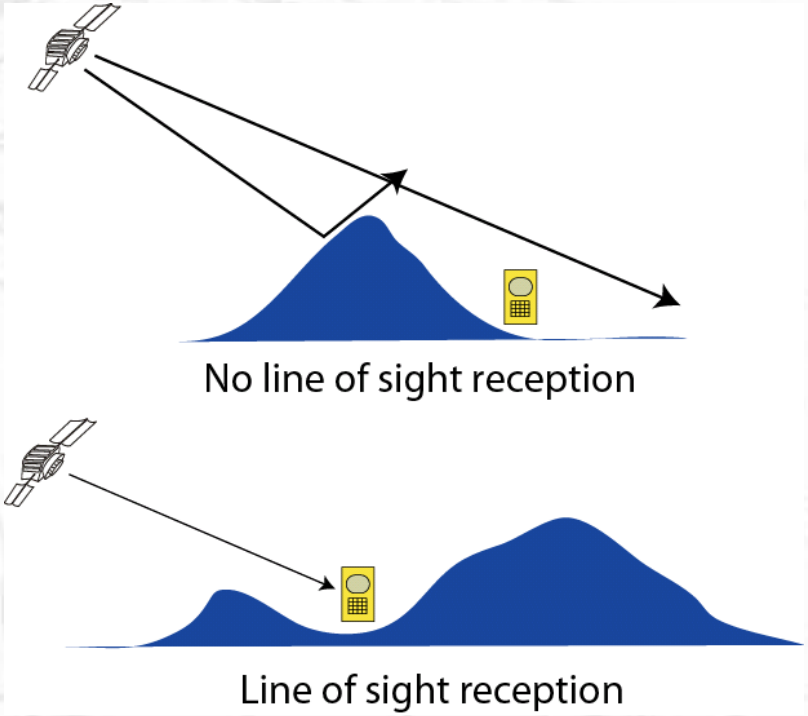






Line of Sight Transmissions

Line of sight is the ability to draw a straight line between two objects without any other objects getting in the way. GPS transmission are line-of-sight transmissions.



Obstructions such as trees, buildings, or natural formations may prevent clear line of sight.

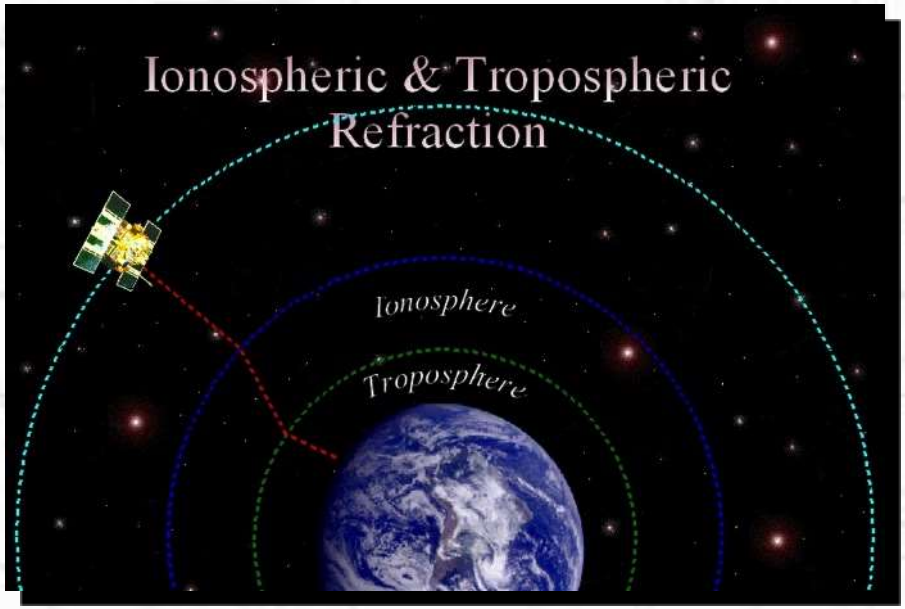
Light Refraction

Sometimes the GPS signal from the satellite doesn't follow a straight line.

Refraction is the bending of light as it travels through one media to another.

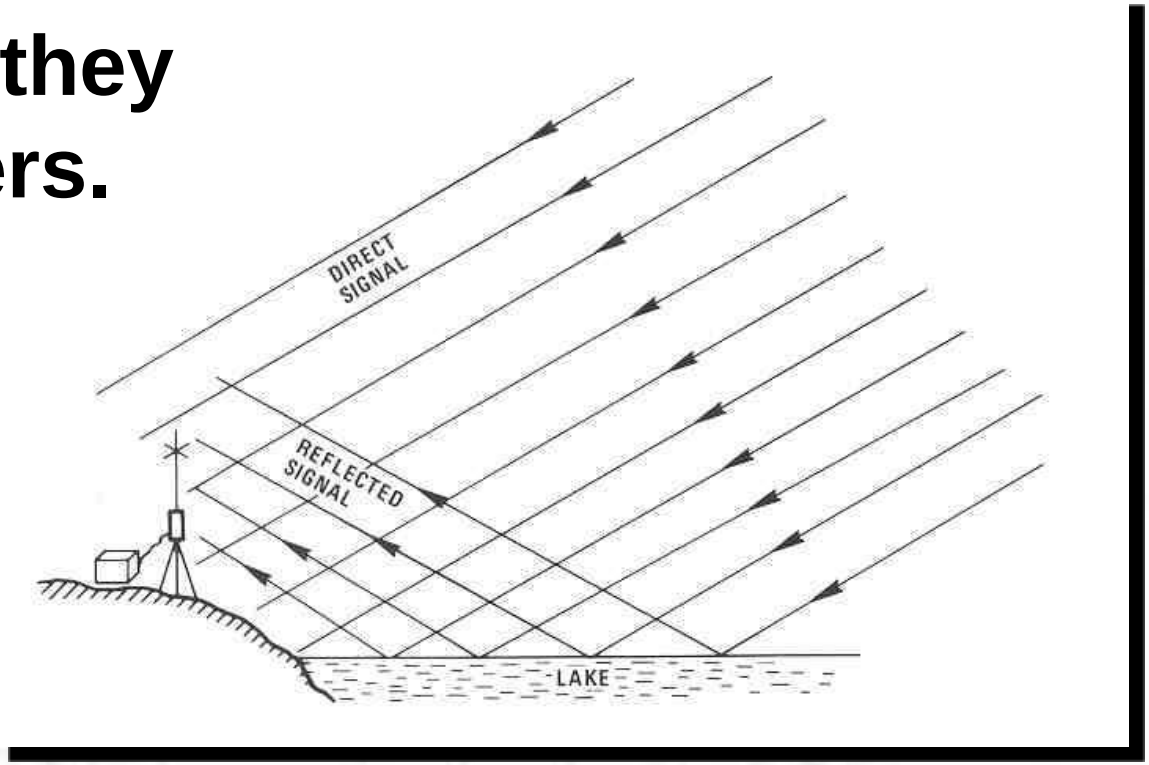
Signal Refraction

Signals from satellites can be like light. When they hit some interference (air patterns in the atmosphere, uneven geography, etc.) they sometimes bend a little.



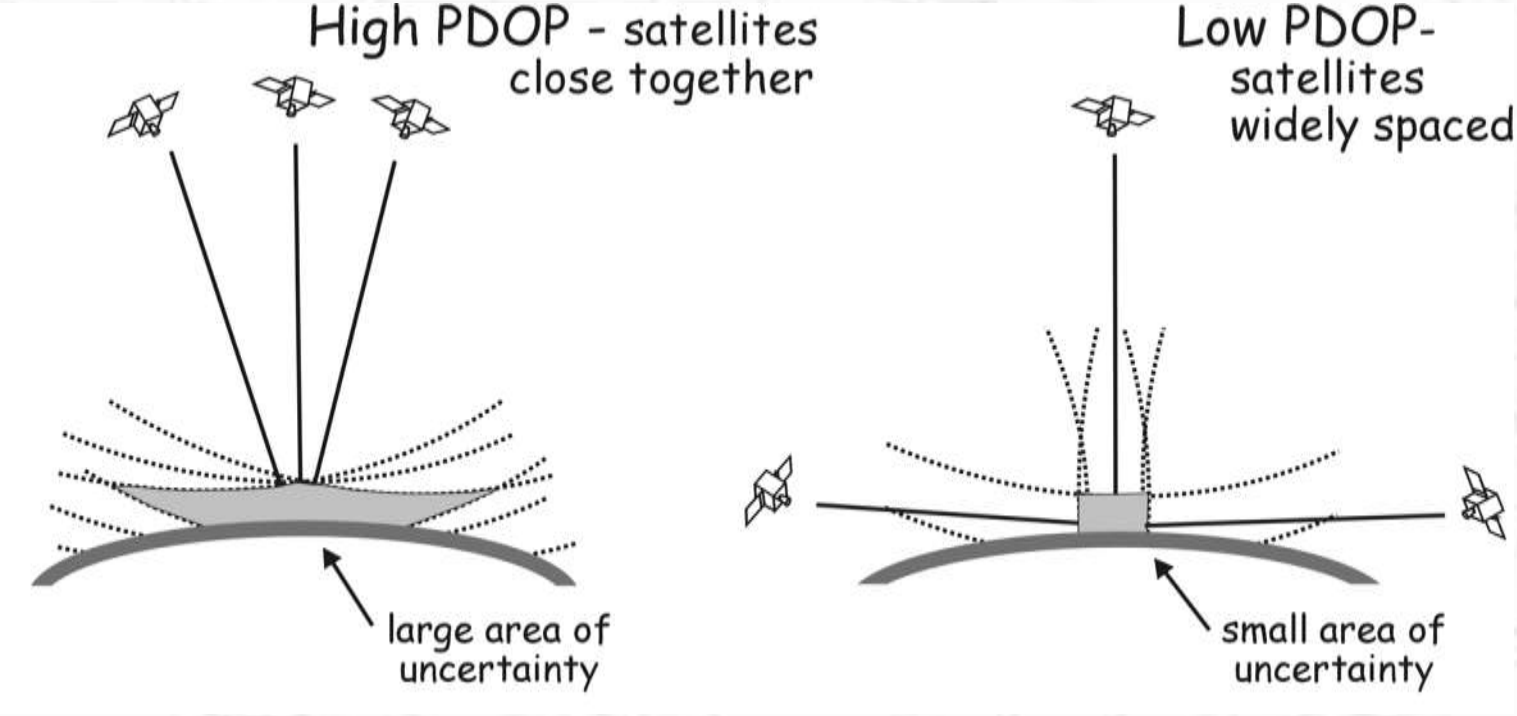
Signal Interference

Sometimes the signals bounce off things before they hit the receivers.



Satellite Distribution

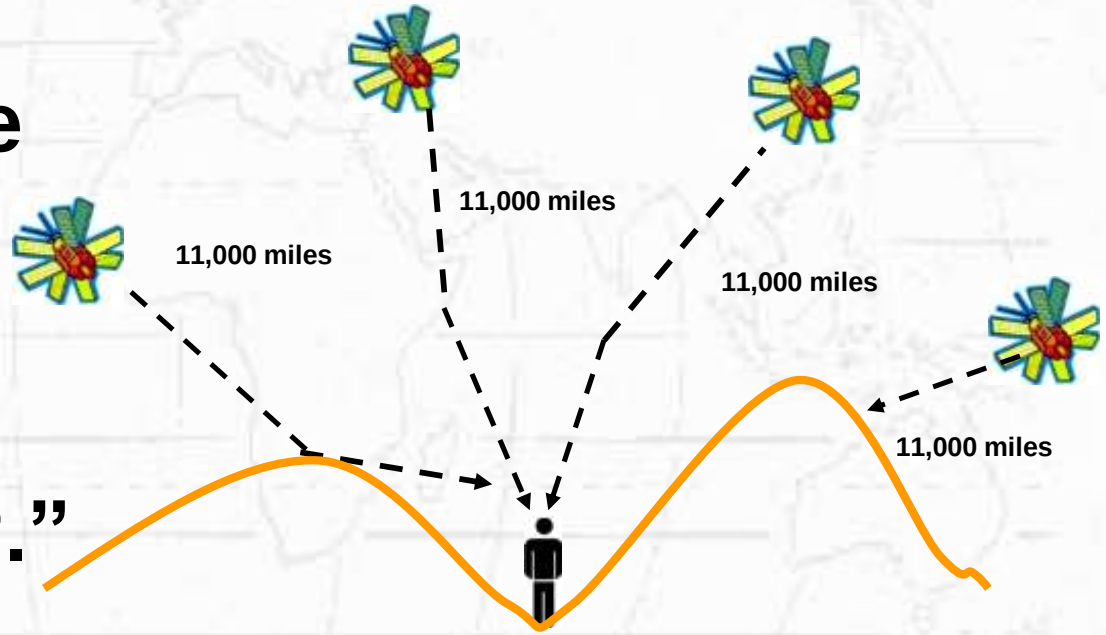
When the satellites are all in the same part of the sky, readings will be less accurate.



PDOP

PDOP = Positional Dilution of Precision

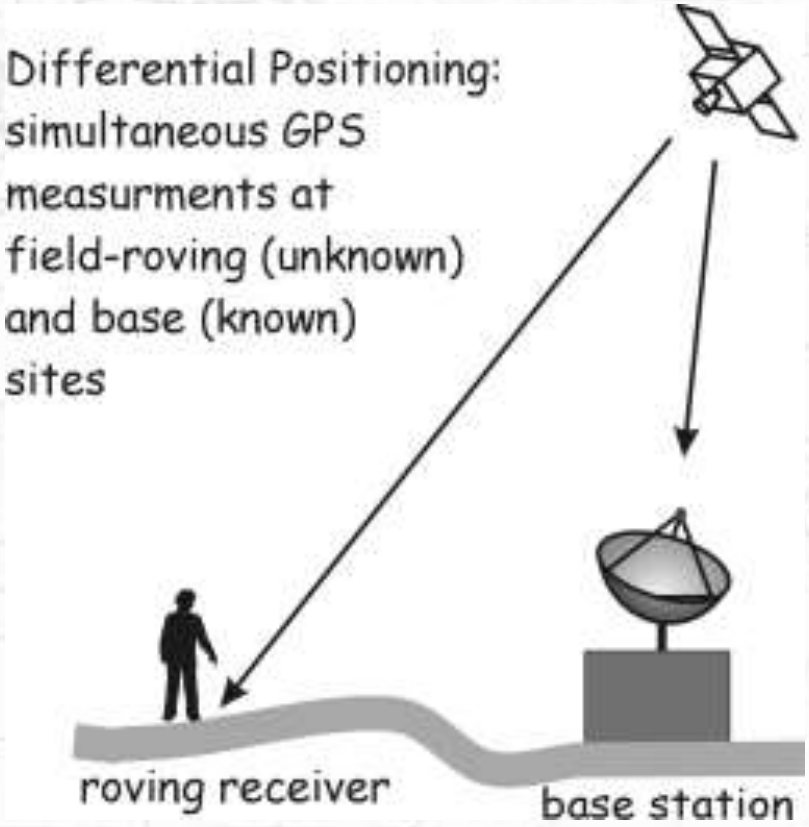
All of this combines to make the signal less accurate, and gives it what we call a high "PDOP."



- ***A PDOP of <4 is excellent***
- ***A PDOP of 4-8 is good***
- ***A PDOP of >8 is poor***

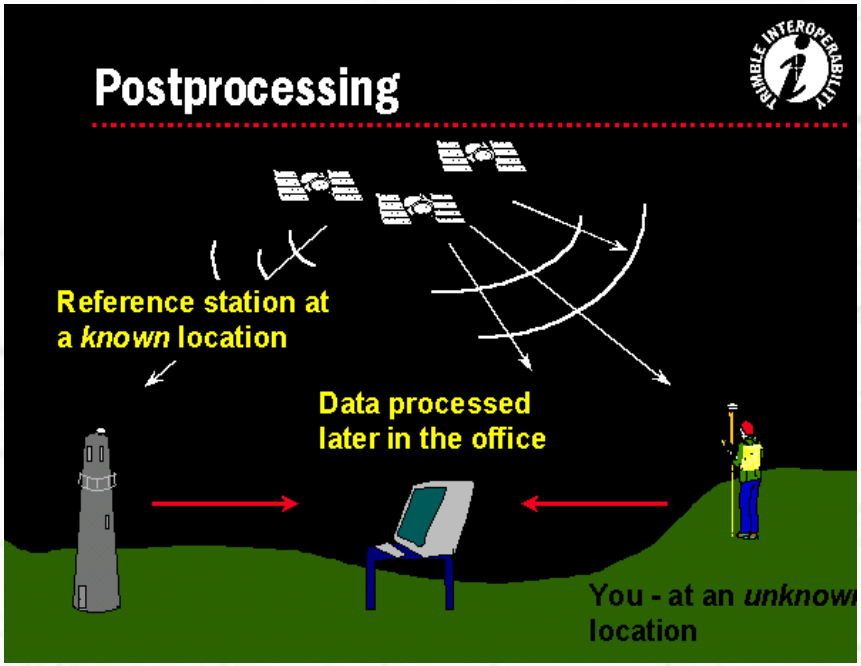
Differential Correction

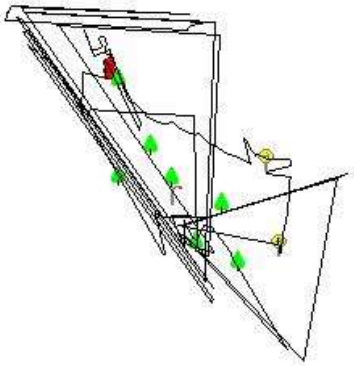
Differential correction is a technique that greatly increases the accuracy of the collected GPS data. It involves using a receiver at a known location - the "base station"- and comparing that data with GPS positions collected from unknown locations with "roving receivers."



ISU Base Station - http://134.50.65.125/

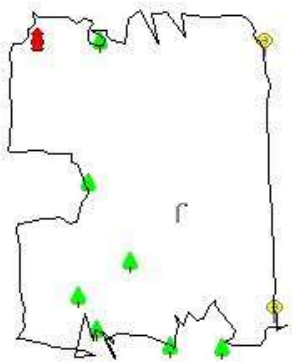
Postprocessing / Real-time

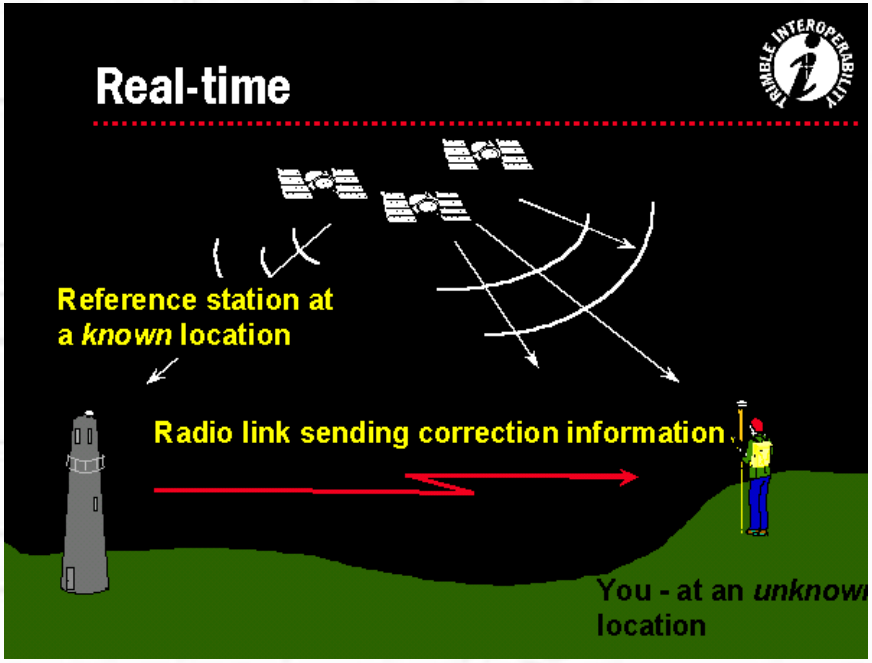




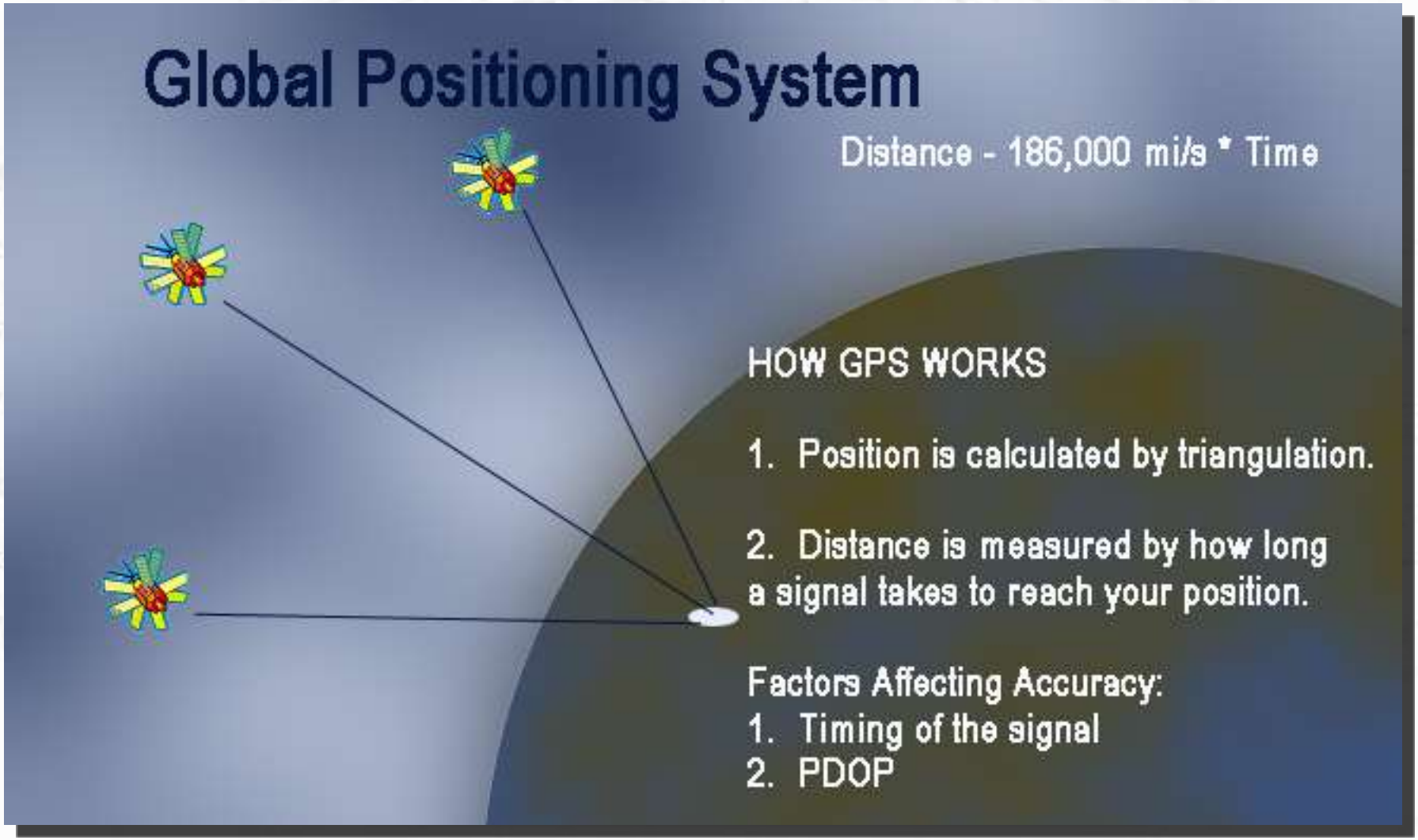
Before

After



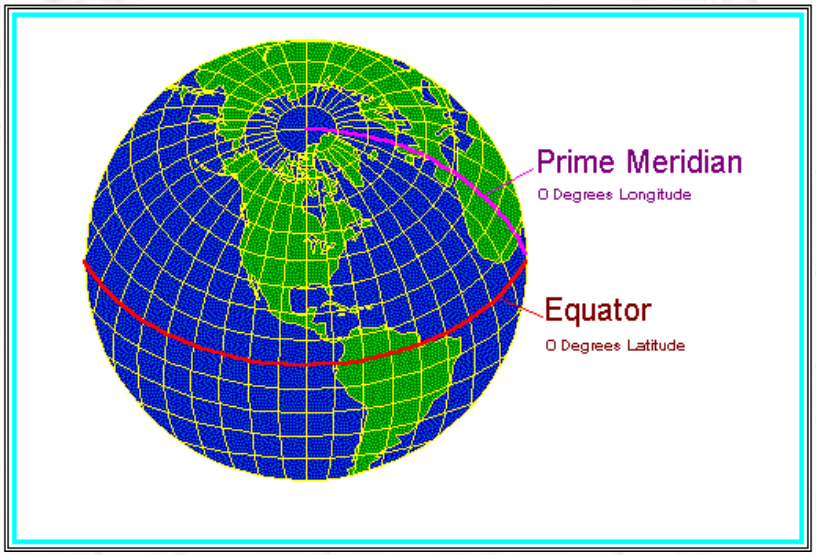


In a Nutshell



Latitude and Longitude

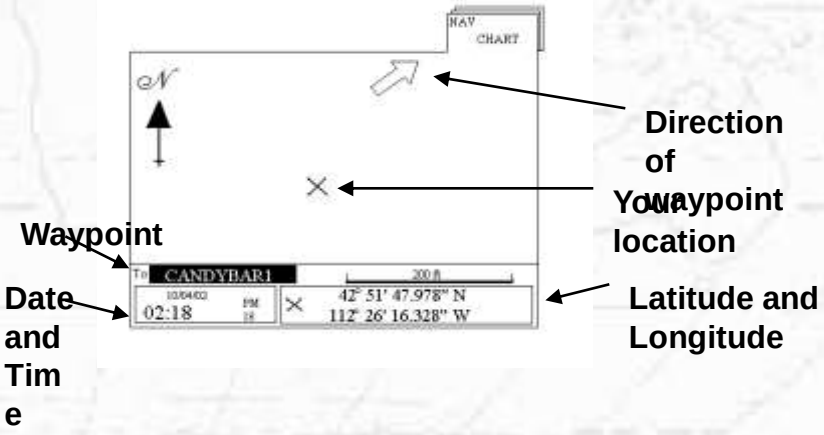
Latitude and Longitude are *spherical coordinates* on the surface of the earth. Latitude is measured North or South of the Equator. Longitude is measured East or West of Greenwich. GPS uses Latitudes and Longitudes to reference locations.



Waypoints

Waypoints are locations or landmarks that can be stored in your GPS. Waypoints may be defined and stored in the unit manually by inputting latitude and longitude from a map or other reference.

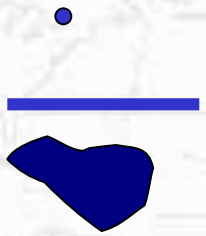
Or more usually, waypoints may be entered directly by taking a reading with the unit at the location itself, giving it a name, and then saving the point.



Data Dictionary

GPS units collect data in:

- **Points**
- **Lines**
- **Areas**



These are called features.

A data dictionary is a means by which we collect specific information about a data feature.