**GNSS Candidates**

Question #1

Explain, briefly, the main error terms contributing to positioning error in GPS satellite navigation. How are these eliminated in differential GPS? What error sources remain?

Answer

It has been found on

<http://www.mio.com/technology-gps-accuracy.htm>

<https://en.wikipedia.org/wiki/Error_analysis_for_the_Global_Positioning_System#Atmospheric_effects>

<http://www.trimble.com/gps_tutorial/howgps-error2.aspx>

The Global Positioning System (GPS) can provide location, altitude, and speed with near-pinpoint accuracy, but the system has intrinsic error sources that should be taken into account when a receiver reads the GPS signals from the constellation of satellites in orbit.

The **main** GPS error source is due to inaccurate time-keeping by the receiver's clock. Microwave radio signals travelling at the speed of light from at least three satellites are used by the receiver's built-in computer to calculate its position, altitude and velocity.

Tiny discrepancies between the GPS receiver's onboard clock and GPS time, which synchronizes the whole global positioning system, mean distances calculated can drift. There are two solutions to this problem. The first would be to use an atomic clock in each receiver costing $100,000. The second is to use some clever mathematical trickery to account for the time-keeping error based on how the signals from three or more satellite signals are detected by the receiver, which essentially allows the receiver to reset its clock. The latter is the less expensive solution used by Navigation device manufacturers.

There is also an intrinsic error source in GPS associated with the way the system works. GPS receivers analyze three signals from satellites in the system and work out how long it has taken each signal to reach them. This allows them to carry out a trilateration calculation to pinpoint the exact location of the receiver. The signals are transmitted by the satellites at a specific rate.

Unfortunately, the electronic detector in standard GPS devices is accurate to just 1 percent of a bit time. This is approximately 10 billionths of a second (10 nanoseconds). Given that the GPS microwave signals travel at the speed of light, this equates to an error of about 3 meters. So standard GPS cannot determine position to greater than 3-metre accuracy. More sophisticated GPS receivers used by the military are ten times more accurate to 300 millimeters.

Other errors arise because of atmospheric disturbances that distort the signals before they reach a receiver. Reflections from buildings and other large, solid objects can lead to GPS accuracy problems too. There may also be problems with the time-keeping accuracy and the data onboard a particular satellite. These accuracy problems are circumvented by GPS receivers which endeavor to lock on to more than three satellites to get consistent data.

https://d.adroll.com/cm/index/outhttps://d.adroll.com/cm/n/outIntentional Errors!

As hard as it may be to believe, the same government that spent $12 billion to develop

the most accurate navigation system in the world intentionally degraded its accuracy.

The policy was called "Selective Availability" or "SA" and the idea behind it was to make

sure that no hostile force or terrorist group can use GPS to make accurate weapons.

Basically the DoD introduced some "noise" into the satellite's clock data which,

in turn, added noise (or inaccuracy) into position calculations. The DoD may have

also been sending slightly erroneous orbital data to the satellites which they transmitted

back to receivers on the ground as part of a status message.

Together these factors made SA the biggest single source of inaccuracy in the system.

Military receivers used a decryption key to remove the SA errors and so they're much more

accurate.