

Topic:

Applications of GPS. Security measures on the system

Aim:

In this seminar we cover the types of applications of GPS and the security systems on the satellites.

Discussion

Applications of GPS: GPS provides positions with accuracies between tens of meters and sub-millimeter depending on observables and the method of use:

Observables (availability translates into cost of receivers)

Cheapest (\$100-\$300): L1 only pseudo range: Accuracy currently of about 10 m (this was the class of receiver used in the candy hunt.

Intermediate (\$1000-\$3000): There are several classes of receivers in this range. Some provide L1 carrier phase allowing differential positioning over tens of kilometers to 10 mm and better. Some low cost receivers are now offering L2 tracking which is made difficult by Antispoofing (see below). When the Block III series of GPS satellites are launched and CA code (or equivalent) is available on L2, the cost of these receivers should drop to a few hundred dollars.

Expensive (\$10,000-\$30,000): L1 and L2 measurements of pseudo range and carrier phase. When left stationary for 24-hours, these receivers can determine positions with sub-millimeter precision in latitude and longitude and a few millimeters in height. When moving, centimeter-level positioning is possible even with hundred km site separations.

Really Expensive (few hundred thousand dollars): Space qualified GPS receivers used for atmospheric profiling and spacecraft positioning to a few centimeters.

Military applications:

Wide spread use in the military. Most often seen in the news is smart-bombs that allow guidance of ordinance to within a few meters of the desired target. Also used for troop positioning and then guidance of ordinance near but not on troops. General navigation applications for vehicles of all types. Registering image data (from space) onto coordinates for field maps (formerly the Defense Mapping Agency (DMA) now National Imaging and Mapping Agency (NIMA). NIMA along with the Air force maintains the GPS tracking sites for determination of the broadcast ephemeris. Army corp of Engineers and Coast Guard maintain differential GPS systems for navigation around the coast and along major waterways such as the Mississippi River.

Civilian applications

Wide spread use in non-military applications ranging from tens of meter navigation to

tectonic study of earthquake regions and volcanoes to weather forecasting using water vapor sensed by GPS ground stations and orbiting satellites equipped with GPS (e.g., GPSMet, CHAMP, GRACE).

Security systems

Selective Availability (SA): No longer turned on but was meant to deny non-authorized users positioning to better than 100 m. Main implementation was

8364;ædithering 8364; of the satellite through a pseudo random sequence that could be removed if the correct code was known (military receivers). SA was found to not be effective when differential GPS systems were used.

Anti-Spoofing (AS): System in which an additional code (W-code) is superimposed on the P-code to generate the Y-code. Because the W-code is secret, an authorized GPS receiver can tell when a false GPS signal is being transmitted. AS have been on since 1992 and affects the signal-to-noise ratio of civilian tracking of L2 making them more prone to radio interference and more expensive. Additional GPS frequencies in the next generation of satellites will make this problem go away although AS will still be turned for L2 signal generation (additional frequencies will transmit with known codes).