

GLOBAL POSITIONING SYSTEM (GPS) ERRORS & LIMITATIONS FOR VEHICLE TRACKING

A White Paper

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Abstract

With the rapid growth in the marketplace of GPS (Global Positioning System) in passenger and commercial vehicles, it is important for consumers of these products to understand exactly what to expect from such systems. Widely promoted these days as the ultimate navigation and vehicle-tracking tool, GPS systems are in fact fragile, prone to error, easily disabled, and best suited for navigation purposes only.

GPS Errors

How accurate are GPS receivers? This is a big question that requires a multi-faceted response. Key factors related to the position accuracy are:

I. Orbital Error

Actual position of the satellite in space versus its predicted position.

I. Clock Errors

Both the satellite and the receiver require very precise clocks to function properly; the receiver clock is typically a weak link due to cost considerations.

I. Atmospheric Errors

Satellite signals travel over 20,000km, including a trip through the Earth's ionosphere and troposphere, both regions of charged particles that distort the signal. An additional concern for Canadian users is that the further North you are, the greater this error becomes due to the longer signal path through these latitudes.

I. Multipath Errors

These result when the satellite signal is reflected off of some nearby object, like a person, a building, a roof, trees, dense foliage, a mountain, etc. Unless the GPS device has a clear sky view i.e. unobstructed in ALL directions and a minimum of 4 satellites in view, multipath errors are very likely.

I. Receiver Noise

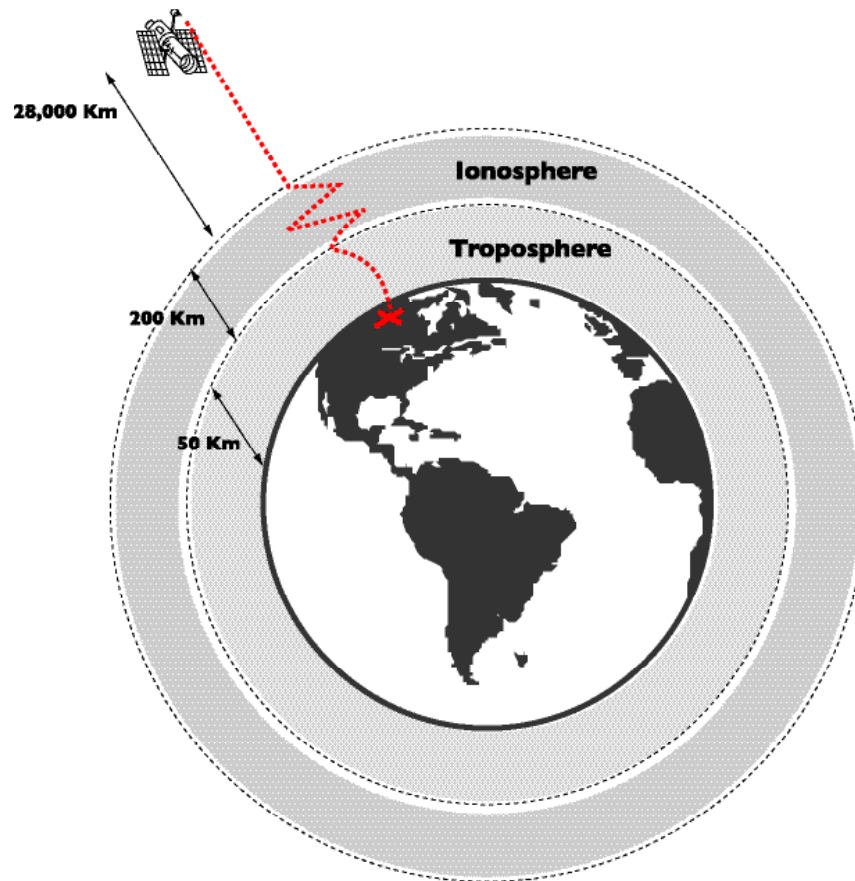
This depends on the quality of the electronics employed in the GPS unit and translates into the cost of the unit. Consumer GPS units are lower cost, higher noise devices.

I. Relativistic Corrections

Both of Einstein's theories of General Relativity and Special Relativity must be incorporated into the software/firmware built into receivers. These complex equations correct for the speeds of the satellites and their locations in the Earth's gravitational field very different from those of the receiver. Expert physicists have questioned receiver manufacturers' software. Errors in the subtle relativistic corrections lead to errors of tens of meters or larger in positional accuracy.

Accuracy

All of the above-mentioned errors combine to provide an approximate position accuracy of 25 meters. This might be larger in some instances and smaller in others. However, any claims that GPS is accurate to a few feet is not supported by fact. Unless you were standing in the middle of an intersection with your GPS device, with an unobstructed view of the sky in all directions, and you plotted your position on a map and the map showed the center of this intersection, you would not get an accurate position reading.



Improving Accuracy

Since the accurate determination of a position by GPS depends so much on the various types of errors inherent in the technology, any means of reducing these errors will naturally yield more accurate results. Orbital, multipath and atmospheric errors cannot be controlled for a given track. That leaves only clock errors and receiver noise as controllable variables. Unfortunately, the only way to achieve an improvement in these problem areas is through the use of much more sophisticated and costly equipment. In fact, whereas small commercial GPS receivers can be purchased for under \$500, equipment that would have accuracies better than 10 meters costs anywhere from \$5,000 to \$10,000 or more. These are primarily used for Global Mapping and Geographic Information Applications. Beyond this, there are "Survey Grade" receivers, costing tens of thousands of dollars, not readily available, and for specific land survey and military applications only.

Positioning and Navigation versus Vehicle Tracking

The fact that a basic GPS device may determine a position to an accuracy of approximately 25 meters means that such equipment is suitable for basic navigation and fleet management. This is because a traveler in an unfamiliar city, a dispatcher checking on the location of his fleet of trucks, or a parent following the whereabouts of their teenaged driver wish only to have an approximation of location. More importantly, these vehicles are relying on the GPS technology in order to provide their owners with important and relevant data. They wish to be “seen” by the minimum of 4 satellites, and they travel in the open with a clear sky view wherever possible.

On the other hand, stolen vehicle tracking involves the location of vehicles that do not wish to be found. This means that these vehicles will be driven by professional thieves who will most likely disable the GPS system by breaking or covering the easily-found antenna, move the vehicle underground or into garages and containers and avoid open sky regions whenever possible. Furthermore, a stolen vehicle that is moving at normal city speeds, let alone highway speeds, will send widely fluctuating positional data due to all of the error sources listed above, especially multipath errors. Tracking a stolen vehicle by GPS is an error-prone, imprecise and unreliable process.

Insurance Industry Support

In addition to the reliability and likelihood of vehicle retrieval in the event of a theft, Insurance company executives are concerned about fraud and what can be done to reduce it. With the advent of mileage restrictions on vehicle leases, new gap and replacement value insurance products sold at new car dealers favour an increased rate of customer-related fraud.

Most GPS vendors have limited or no resources to support insurance companies and their investigators. By contrast, cellular-based Boomerang Tracking Inc. provides insurance investigators and adjusters with detailed vehicle movement leading up to the theft. In addition, its Director of Security, a former Chief of Police, collaborates on each and every theft investigation, providing location data and vehicle proximity crucial to the adjusters' determination as to the possibility of a fraudulent claim.

Installation

Installation of GPS systems poses serious problems, limiting its efficiency when tracking stolen vehicles. The GPS antenna cannot be hidden under metal; otherwise the signals will be blocked. This antenna must also be visible to the 4 satellites to which it is tuned; otherwise no positioning is possible. On a typical vehicle, this leaves only antenna locations under the dashboard or under the rear window. In the case of SUVs, even the rear window cannot be used as it is too vertical a surface, leaving only the under dash for its placement. As a result, professional thieves can quickly and easily locate and disable the antenna, rendering the GPS device useless.

Many GPS vendors permit almost anyone to install their devices, including most new car dealers. It has been demonstrated in the past that many theft-related activities were initiated internally. It is therefore critical to select a vendor that carefully controls and monitors the quality of installations performed by its dealers, and also certifies its installers.

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Claude Arpin, Director of Research and Development, is responsible for overseeing all research and development efforts for Boomerang Tracking Inc., keeping product offerings technically sound and technologically superior. His background includes more than fifteen years of experience in all phases of the development of electronic products from concept to design, prototyping and manufacturing to marketing and sales. As third party developer for Apple Computer, Mr. Arpin developed the first robotic controller used in the education market. In 1992, he started an enterprise that specialized in automotive application, the first to propose Surface Mount Technology ("SMT") designed products.