1.0 Introduction to GPS

The **global positioning system (GPS)** is a network of 24 satellites that orbit the Earth's surface and provide signals that can be used to determine specific locations. GPS was originally called the NAVSTAR system (which is an acronym for Navigation Satellite Timing and Ranging) and was developed by the US Department of Defense. GPS was designed for the military; however an executive decree in the 1980s expanded its use to the civilian population.

The signal transmitted by the satellites for location positioning is a low power radio signal. The signal is transmitted at all times and is available at no cost. The reliability and economics of GPS are probably the reasons for its wide range use.

Space, control, and users

GPS can be divided into three segments: space (or satellites), control (ground station), and users (yourself and your GPS receiver).

The **space segment** of GPS includes the 24 satellites that are in constant orbit around the Earth. GPS satellites are powered by solar energy and backup batteries and have a lifespan of approximately 10 years. The satellites are positioned at high altitudes (~12,000 miles) allowing for any GPS receiver on Earth to be able to receive signal from at least 4 satellites at all times. The signal that is available to civilians is called the 'L1' frequency and travels as 'the line of sight'. This means that the signal will pass through things you can see through (e.g., glass, clouds, plastic) but not through most solid objects (e.g., trees, buildings).

The **control segment** of GPS is the portion that tracks the satellites and corrects their signal for orbit and time. There are four unmanned signal receivers and one master control station around the world. These stations work together by receiving signal from satellites and sending corrected information back to the satellites.

The **user segment** is the GPS receiver you are using and yourself.

GPS receivers

GPS receivers use at least three satellites to 'triangulate' their position on Earth. To triangulate, the distance between the receiver and the satellites is measured using the radio signals collected by the GPS receiver. This is determined by knowing the exact position of the satellites in space and the time of travel for the radio waves. GPS receivers collect two codes from satellites. One of the codes is the almanac data which relays information on the approximate position of the satellites. This data is periodically updated as the position of the satellites change. The second code received by the GPS is the ephemeris data which is information that corrects the signal for any deviations in satellite position. Using these two codes, receivers can determine their location.

Corrections (often referred to as differential corrections or **DGPS**) to the signal must also be made to account for atmospheric errors. In the old days (1990s), this was done by using a 'rover' GPS and a base station. The base station would be placed over a known location which would be programmed into the equipment. Generally this was a survey marker. Based on the differences between the signal received by the rover from GPS satellites and its known location a correction factor would be determined. The rover would be moved to points of interest and each location would be saved into the GPS computer. The base station correction factor would then be used to correct the values recorded in the rover GPS computer. This type of application works because the atmospheric errors were assumed to be similar at both the receiver and the rover locations.

Now, things can be done differently for differential correction. New technology is available!! Beacon stations are located throughout the world providing corrections for atmospheric errors. Use of beacon stations is free. Beacon stations may or may not be available in your area, so be sure and check this out before buying equipment. Beacon

stations transmit correction data that is collected by a beacon receiver. The beacon receiver acts similar to the old base stations. Beacon receivers use this information to correction information stored in the GPS receiver. Use of a beacon receiver in conjunction with a GPS receiver will provide you with accurate position information.

Without DGPS, position measurements may have several meters of error. With DGPS, position measurements will be within the error associated with your GPS receiver.

For more information on GPS please see:

El-Rabbany, A. 2002. Introduction to GPS: The Global Positioning System. Artech House, Linc.: Norwood, MA.

Leick, A. 2004. GPS Satellite Surveying. John Wiley & Sons, Inc.: Hoboken, NJ.