Introduction

The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 30 satellites placed into orbit by the U.S. Department of Defense. GPS was originally intended for military applications, but in the 1980s, the government made the system available for civilian use[1]. The allowance of civilian use has created a large, rapid growing market for devices that can access the information provided by GPS. Many applications such as navigation and tracking have greatly increased the consumer demand of GPS devices. This paper focuses on the currently available commercial uses of GPS and the technologies behind GPS.

Current Applications

The first commercial GPS devices were limited to an accuracy of 100m because the Defense Department inserted timing errors into its transmissions to limit the accuracy of nonmilitary GPS receivers to 100 meters. However, this "selective availability" was eliminated in May 2000[2]. Current, well designed GPS receivers have been achieving horizontal accuracy of three meters or better and vertical accuracy of five meters or better 95% of the time[5]. This increase in accuracy allowed for more navigation applications. The most popular commercial application for GPS is as a navigation device in vehicles. Due to the increased accuracy, these navigation devices can provide the driver with a live map of their location as well as turn-by-turn directions. According to an article in Directions Magazine, "Today's GPS-enabled devices are being adopted by anyone using maps or other forms of digital mapped data, including the middle-aged and elderly.[4]" Companies like SageQuest offer fleet tracking services for other companies that rely on a fleet of vehicles. The location of the vehicles being tracked is acquired using GPS and the GPS data is relayed to SageQuest through cell phone networks. SageQuest can alert clients of fleet vehicles that are speeding, sitting idle, leaving a set boundary or many other events[3].

Underlying Infrastructure

All GPS applications rely on the US Department of Defense's constellation of satellites that make up the Global Positioning System. The constellation contains 30 operational satellites. Each satellite broadcasts its precise location with respect to the earth along with the time of transmission. The time is based on atomic clocks and therefore highly accurate. When a GPS receiver receives a signal, the receiver calculates its distance from the satellite by measuring the amount of time it took the transmission to reach the receiver. Ideally, a GPS receiver would only

need signals from three satellites but, due to inherent errors in the calculation of distance, more satellites are needed to compensate for errors. Once the GPS receiver has locked onto at least four satellite signals, the receiver can calculate its three-dimensional position on the earth by triangulation. Other properties as far as speed and direction can also be derived.

Implementation

Several low-power GPS modules are currently available. Trimble produces a GPS module that uses 93.9mW of power[6]. Once integrated into a design, Trimble's product can communicate over two serial ports. Its supported protocols include TSIP, TAIP, and NMEA. The two frequencies that it operates at are 1575.42 MHz and 1227.6 MHz, so an antenna tuned to those frequencies would be the only additional hardware needed to support Trimble's module. The only software needed to use Trimble's module would be software that can translate the previously mentioned protocols into the appropriate positioning information.

[1] “What is GPS?,” Garmin. [Online]. Available: http://www8.garmin.com/aboutGPS/. [Accessed: Jan. 19, 2009].

[2] Cheryl Pellerin, “United States Updates Global Positioning System Technology,” America.gov, Feb. 3, 2006. [Online] Available: http://www.america.gov/st/washfile-english/2006/February/20060203125928lcnirellep0.5061609.html. [Accessed: Jan. 19, 2009].

[3] SageQuest, *Mobile Control from SageQuest*, Solon, Ohio.

[4] Owen Shapiro and Bob Yovovich, “Consumer Awareness Driving GPS-enabled Device Adoption," Directions Magazine, Nov. 01, 2007.

[5] US Department of Defense, *Global Positioning System Standard Positioning Service Performance Standard*, 4th Edition, Sep. 2008.

[6] Trimble Technical Staff, “Copernicus GPS Receiver Datasheet,” Trimble, Feb. 2006.