16. User Segment

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The U.S. Federal Aviation Administration (FAA) estimated in 2006 that some 500,000 GPS receivers are in use for many applications, including surveying, transportation, precision farming, geophysics, and recreation, not to mention military navigation. This was before in-car GPS navigation gadgets emerged as one of the most popular consumer electronic gifts during the 2007 holiday season in North America.

Basic consumer-grade GPS receivers, like the rather old-fashioned one shown below, consist of a radio receiver and internal antenna, a digital clock, some sort of graphic and push-button user interface, a computer chip to perform calculations, memory to store waypoints, jacks to connect an external antenna or download data to a computer, and flashlight batteries for power. The radio receiver in the unit shown below includes 12 channels to receive signal from multiple satellites simultaneously.

Figure 5.17.1 Recreation-grade GPS receiver, circa 1998.

NAVSTAR Block II satellites broadcast at two frequencies, 1575.42 MHz (L1) and 1227.6 MHz (L2). (For sake of comparison, FM radio stations broadcast in the band of 88 to 108 MHz.) Only L1 was intended for civilian use. Single-frequency receivers produce horizontal coordinates at an accuracy of about three to seven meters (or about 10 to 20 feet) at a cost of about $100. Some units allow users to improve accuracy by filtering out errors identified by nearby stationary receivers, a post-process called "differential correction." $300-500 single-frequency units that can also receive corrected L1 signals from the U.S. Federal Aviation Administration's Wide Area Augmentation System (WAAS) network of ground stations and satellites can perform differential correction in "real-time." Differentially-corrected coordinates produced by single-frequency receivers can be as accurate as one to three meters (about 3 to 10 feet).

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The signal broadcast at the L2 frequency is encrypted for military use only. Clever GPS receiver makers soon figured out, however, how to make dual-frequency models that can measure slight differences in arrival times of the two signals (these are called "carrier phase differential" receivers). Such differences can be used to exploit the L2 frequency to improve accuracy without decoding the encrypted military signal. Survey-grade carrier-phase receivers able to perform real-time kinematic (RTK) differential correction can produce horizontal coordinates at sub-meter accuracy at a cost of $1000 to $2000. No wonder GPS has replaced electro-optical instruments for many land surveying tasks.

Meanwhile, a new generation of NAVSTAR satellites (the Block IIR-M series) will add a civilian signal at the L2 frequency that will enable substantially improved GPS positioning.

‹ 15. Control Segment up 17. Satellite Ranging ›

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