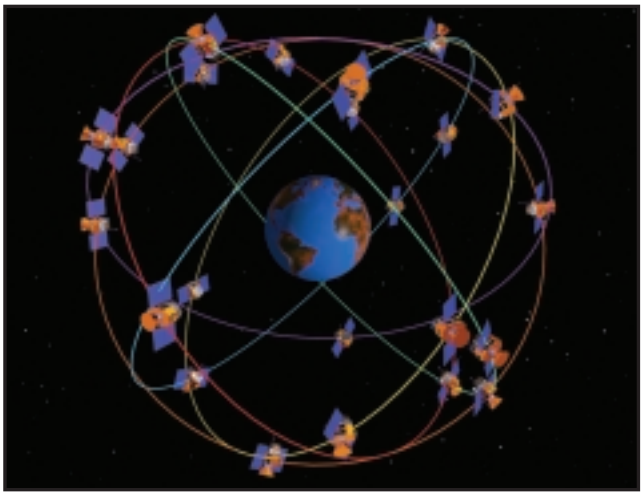
Locating, locating, locating

Originally designed for military use, the Global Positioning System (GPS) now lets boaters, drivers, and hikers pinpoint their location to within a few meters. Most of GPS's functionality is derived from arithmetic, algebra, and geometry. The time it takes for a signal to travel from a transmitting satellite to a GPS receiver establishes the distance between the two, which places the GPS user on an imaginary sphere centered at the satellite. Similar calculations are done concurrently using other satellites. Once corrections for the difference between satellite and receiver clocks are made, the GPS user's location must be one of the points of intersection of three spheres.

The basic principles of GPS are simple, but reducing error when using satellites more than 10,000 miles away to calculate locations is not. Information theory extracts reliable data from weak signals (which have less than a billionth of the power of those received by your television) and mathematical models of the atmosphere account for slight changes in speed as signals travel through different layers on their way to earth. Differential GPS reduces error even further by using land-based stationary receivers, whose precise positions are known. Eventually real-time GPS will be so accurate — with errors on the order of inches — that it will guide cars and allow planes to land in zero visibility.

For More Information: "Retooling the Global Positioning System," *Scientific American*, Per Enge, May 2004.



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