How The Global Positioning System Works

Triangulation By Satellite

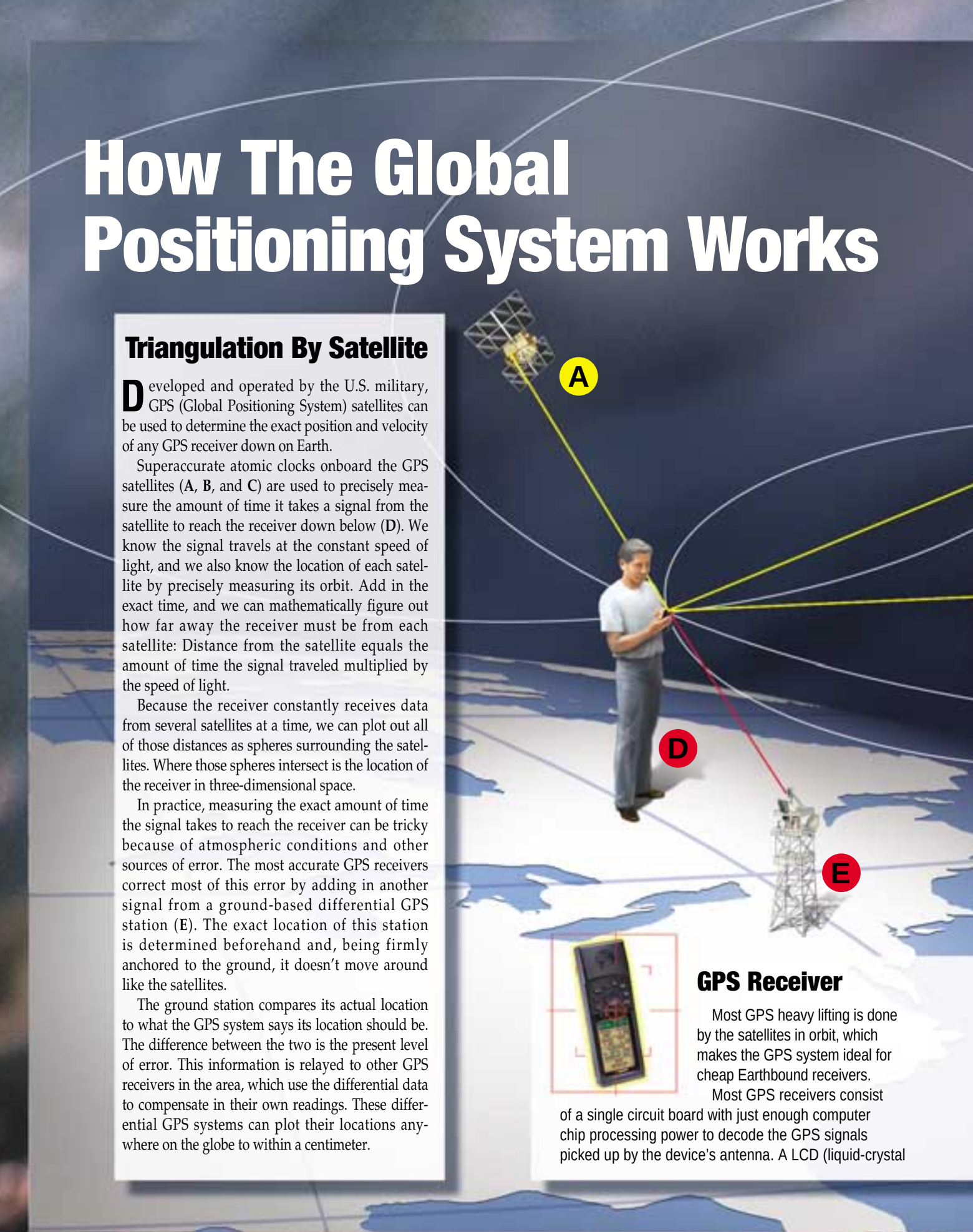
Developed and operated by the U.S. military, GPS (Global Positioning System) satellites can be used to determine the exact position and velocity of any GPS receiver down on Earth.

Superaccurate atomic clocks onboard the GPS satellites (**A**, **B**, and **C**) are used to precisely measure the amount of time it takes a signal from the satellite to reach the receiver down below (**D**). We know the signal travels at the constant speed of light, and we also know the location of each satellite by precisely measuring its orbit. Add in the exact time, and we can mathematically figure out how far away the receiver must be from each satellite: Distance from the satellite equals the amount of time the signal traveled multiplied by the speed of light.

Because the receiver constantly receives data from several satellites at a time, we can plot out all of those distances as spheres surrounding the satellites. Where those spheres intersect is the location of the receiver in three-dimensional space.

In practice, measuring the exact amount of time the signal takes to reach the receiver can be tricky because of atmospheric conditions and other sources of error. The most accurate GPS receivers correct most of this error by adding in another signal from a ground-based differential GPS station (**E**). The exact location of this station is determined beforehand and, being firmly anchored to the ground, it doesn't move around like the satellites.

The ground station compares its actual location to what the GPS system says its location should be. The difference between the two is the present level of error. This information is relayed to other GPS receivers in the area, which use the differential data to compensate in their own readings. These differential GPS systems can plot their locations anywhere on the globe to within a centimeter.

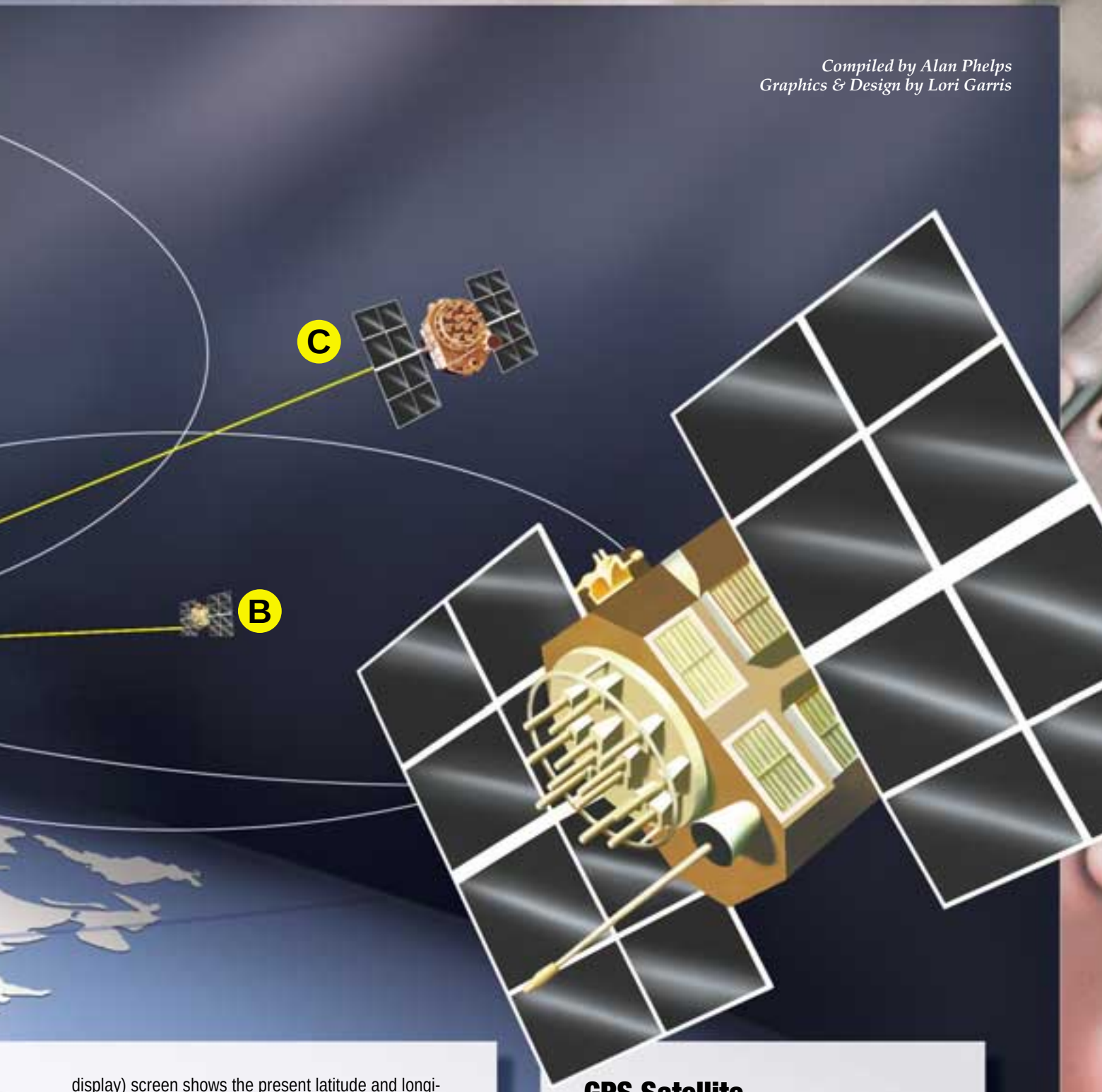


GPS Receiver

Most GPS heavy lifting is done by the satellites in orbit, which makes the GPS system ideal for cheap Earthbound receivers.

Most GPS receivers consist of a single circuit board with just enough computer chip processing power to decode the GPS signals picked up by the device's antenna. A LCD (liquid-crystal

Compiled by Alan Phelps
Graphics & Design by Lori Garris



display) screen shows the present latitude and longitude of the receiver. Some models include enough onboard memory to store maps so the unit's position can be plotted graphically.

A small cadre of buttons lets the user access a limited number of functions, such as displaying the time, zooming in and out on the map, or punching in waypoints for the device to remember. The whole thing is usually powered by standard batteries.

GPS Satellite

The present constellation consists of a combination of 29 Block II, IIA, and IIR satellites, all of which have been manufactured by Rockwell International or Lockheed Martin.These satellites weigh about 1,900 pounds on Earth and have a wingspan of 17 feet from the end of one solar panel to the other. Each satellites circles the planet once every 12 hours at an altitude of 11,000 miles.