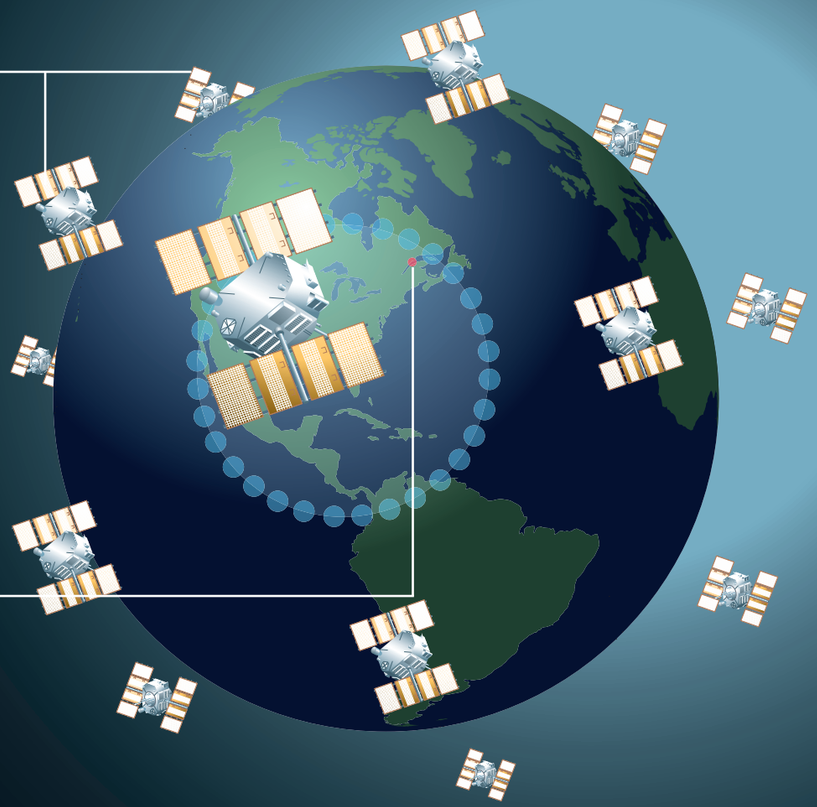
How Your Smartphone Knows Where You Are

TODAY, OUR ELECTRONIC gadgets have a skill most of our mothers would have killed for—the ability to know where we are day or night. What gives this gift to our cell phones, tablets, computers, cars, watches, and even running shoes is GPS—the Global Positioning System—24 beacons in the sky that constantly broadcast the information our devices need to tell us just where we are—and how to get to the nearest Starbucks.

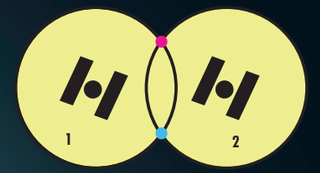
3 On earth, a GPS radio receiver, part of a phone, electronic compass, car mapping system, or a dozen or so other devices, listens to the signals broadcast by at least four satellites. Programmed into the receiver's data is the exact location of each satellite. The GPS device includes a microprocessor that measures how long it took the signals to reach it from each satellite.



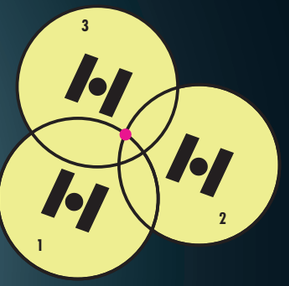
1 The satellites, put into space by the U.S. Department of Defense and a number of other outfits, are locked into geo-synchronous orbits that blanket the earth like the nexus of a giant geodesic dome. Relative to the earth and to each other, the satellites maintain the same steady positions at all times.

2 From any point on earth, between five and eight satellites are visible—or would be if your eyesight were good enough or if you used a telescope. Every thousandth of a second, the satellites broadcast information that identifies each one and the time the signal is sent. A ground station constantly updates and corrects the time signals.

4 Based on a signal from only one satellite, the receiver could be at any point that matches the distance between that one satellite and the receiver. That distance is equal to the radius of a circle that has the overhead position of the satellite at its center and whose circumference represents all the possible locations of the receiver.



5 Now include the information contained in the signals from a second satellite, and the GPS calculations construct a second circle that intersects the first circle at two points. Because both those points are equidistant from the centers of both circles, one of them must be the location of the receiver.



6 A third signal pinpoints the GPS receiver's location—the point at which a circle with the third satellite at its center coincides with one of the two intersections of the first two circles. Because GPS receivers are accurate to within only about few yards, a fourth satellite or more improves the accuracy of the calculations.

7 The longitude and latitude determined by the processor is mapped and turned into a point of light on a phone, tablet, or car's mapping display. If the device with the GPS unit is moving, the dot on the display moves with it. If the display is coordinated by landmark data in the device or with a mapping service database, the map might include symbols for common locations, such as restaurants, service stations, hospitals, malls, and, of course, Starbucks.