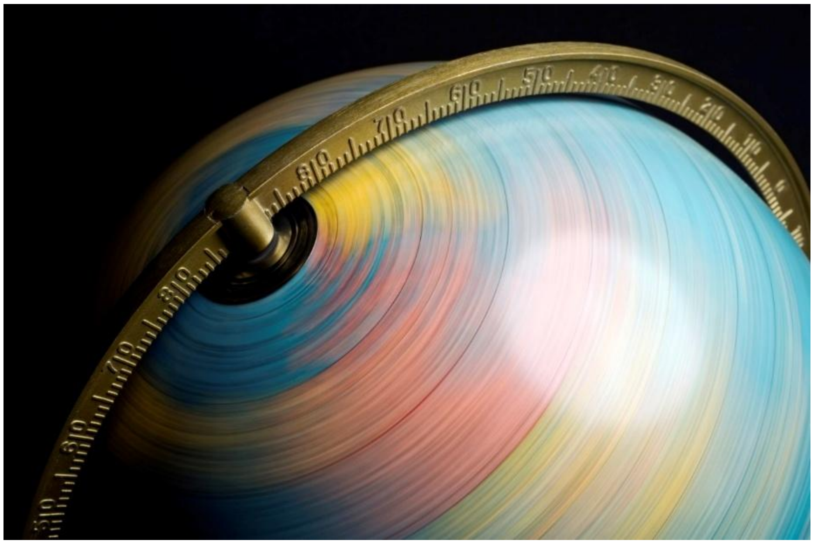
The Intricate System That Lets You Find Yourself

The structure underlying GPS uses distant quasars to locate places on Earth.

Wall Street Journal, By Nishant Sahdev, Aug. 7, 2026



I wrote in these pages last month about the machinery behind a question few people reflect deeply on: What time is it? Civilization runs on a manufactured consensus about time, maintained by atomic clocks and humble institutions. Another deceptively simple question—Where are we?—has a similar answer.

The question seems absurd because we treat location as a fixed property of the ground. It isn't. In 2011 the Tōhoku earthquake carried Japan's main island roughly 8 feet to the east in minutes. Every surveyed coordinate in the country—boundaries, bridges, runways—was suddenly wrong. Australia rides a tectonic plate northeast at a pace of almost 3 inches a year, the speed of a fingernail's growth. The continent had drifted so far from its official coordinates by 2017 that the government moved the entire nation almost 6 feet on paper to reconcile maps with reality. Scandinavia rises from the sea, relieved of its Ice Age glaciers. Coastal cities sink. The Earth's center of mass wanders as ice sheets melt and water shifts.

If the ground moves, position must be measured against something that doesn't. Nothing on Earth qualifies. So scientists anchor the world's coordinates to far-off stillness: quasars, the luminous cores of galaxies billions of light-years away, observed nightly by radio telescopes across multiple continents and cross-checked with lasers bounced off satellites. The result is the International Terrestrial Reference Frame—civilization's master answer to "where." Every deed and flood map, every blue dot on every phone originates from it. GPS is the delivery system, and the quasar-derived frame is the source.

Americans are about to feel this abstraction directly. The federal government is replacing the reference system underlying American coordinates. The old one—built on classic ground surveying—misplaced Earth's center by more than 7 feet. When the new system becomes official in the next year, latitudes, longitudes and elevations across the country will change by as much as 13 feet. Lenders and insurers will pore over the new maps;

homeowners should study them too. Businesses that depend on precise positioning—construction, agriculture, logistics, anything autonomous—should be asking which reference frame their data fit. Costly errors can arise from the gap between here and there.

For most of history, a few feet of ambiguity cost nothing. Not anymore. Driverless machines demand centimeter precision. Sea-level rise is measured in millimeters, so tiny drifts in the reference frame prevent accurate calculations of coastal risk. The frame itself has no owner, no revenue and no lobby. It survives on aging observatories, international cooperation and a scientific community small enough to fit in a lecture hall.

The United Nations passed a resolution in 2015 urging governments to sustain this system. It didn't make headlines. The U.S. rightly designates GPS as critical infrastructure, but the reference frame that gives every GPS signal its meaning enjoys no such protection.

Although GPS satellites are U.S.-owned military hardware, the reference frame relies on an international patchwork of aging radio-telescopes staring at quasars, laser-ranging stations and physical ground markers anchored to shifting tectonic plates. If that network were designated critical infrastructure, it would mean funding and protecting those ground nodes and data pipelines—many of which survive on academic grants.

"When" and "where" weren't given to us by nature. To keep from getting lost, humans must engineer and maintain both frames of reference.

Mr. Sahdev is a physicist at the University of North Carolina at Chapel Hill.