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GPS upgrade aims to see more, do more

By W.J. Hennigan
Los Angeles Times

Without it, ATMs would stop spitting out cash, Wall Street could blunder billions of dollars in stock trades and clueless drivers would get lost.

Most people may associate the Global Positioning System with the navigation devices that are becoming standard equipment on new cars. But GPS has become a nerve center for the 21st century rivaling the Internet â€” enabling cargo companies to track shipments, guiding firefighters to hot spots and even helping people find lost dogs.

"It's a ubiquitous utility that everybody takes for granted now," said Bradford W. Parkinson.

He should know. Three decades ago, as a baby-faced Air Force colonel just out of the Vietnam War, Parkinson led the Pentagon team that developed GPS at a military base in El Segundo, Calif.

Now, scientists and engineers â€” including those at a sprawling Boeing satellite-making factory in El Segundo â€” are developing an \$8 billion GPS upgrade that will make the system more reliable, more widespread and much more accurate.

As part of the upgrade, Boeing is building 12 satellites the size of sport-utility vehicles, and 18 others will be assembled by Lockheed Martin in Denver. Twenty-four will go into orbit, and six will be reserved as spares.

The new system is designed to pinpoint a location within an arm's length, compared with a margin of error of 20 feet or more today. With that kind of precision, a GPS-enabled mobile phone could guide you right to the front steps of Starbucks, rather than somewhere on the block.

"This new system has the potential to deliver capabilities we haven't seen yet," said Marco Caceres, senior space analyst for aerospace-research firm Teal Group. "Because GPS touches so many industries, it's hard to



ALLEN J. SCHABEN / MCCLATCHY NEWSPAPERS
Technician Gladys Wicking looks over Boeing's second GPSIIIF satellite being built in El Segundo, Calif., on March 9. The satellite is among 12 Boeing is building as part of an \$8 billion upgrade to make the GPS system more reliable and widespread.

Ubiquity of GPS

More than 1 billion GPS receivers are used worldwide for navigation.

ATMs and Wall Street traders use super-accurate atomic clocks on the GPS satellites to time-stamp transactions.

"Smart bombs" can be directed to within a few yards of their target by GPS signals.

Two dozen satellites orbiting in formation constitute GPS.

Los Angeles Times

imagine what industry wouldn't be affected."

The 24 satellites that make up the GPS constellation will be replaced one by one. The first Boeing-built replacement was launched Friday from Cape Canaveral.

The overhaul will take a decade and is being overseen by engineers at Los Angeles Air Force Base in El Segundo, where Parkinson and his team developed the current system.

"We know that the world relies on GPS," said Col. David B. Goldstein, the chief engineer for the upgrade.

San Diego found out firsthand in 2007, when the Navy accidentally jammed GPS signals in the area, knocking out cellphone service and a hospital's emergency paging system for doctors. New York experienced a similar problem a year later.

The upgrade is designed in part to prevent such outages by increasing the number of signals beamed to Earth from satellites orbiting 12,000 miles above. By triangulating the signals from four satellites, GPS receivers "and there are now more than a billion of them" can pinpoint your exact location on the ground.

Although "positioning" is an obvious application of the technology, it's also become a crucial timekeeper for the financial industry.

Transactions made everywhere, as varied as ATM withdrawals and Wall Street stock trades, are time-stamped using precise atomic clocks ticking within the GPS satellites. The clocks are accurate to one-billionth of a second. It's a crucial technology for Wall Street, where a fraction of a second could mean billions of dollars.

Before GPS, explorers and seafarers figured out where they were by looking at the sun and the stars. Even with the advent of gyroscopes and radios, navigation was still imprecise, with an average margin of error of a mile or two.

The Cold War sparked the need for something better.

When the Soviet Union launched the world's first artificial satellite, Sputnik, in 1957, scientists at Johns Hopkins University scrambled to track it. They soon realized they could determine Sputnik's position by monitoring the radio waves it emitted.

That led to a breakthrough concept. If radio waves could be used to track a satellite from Earth, radio waves from a satellite could also be used to determine the position of an object on the ground.

The Pentagon jumped at the idea. The Navy in particular needed help guiding its nuclear-armed submarines.

In the 1960s, the Pentagon launched more than a dozen satellites under a program in which subs received satellite- positioning signals when they surfaced. But the system was accurate only to within 100 feet "and only when a submarine wasn't moving. The government needed something better.

In 1972, the Pentagon tapped Parkinson to develop a satellite-based navigation system that had attracted more naysayers than supporters. Parkinson recalled frequent trips to Washington to deflect criticism from politicians and even some Pentagon brass that decried the project as a waste of taxpayers' money.

"I was told that the system was useless and that it had no future," said Parkinson, 75, now professor emeritus at Stanford University. "I guess we proved them wrong."

The first satellite was launched in 1978, and the system began partially operating with 21 satellites in 1993.

The military seized on the technology quickly, using GPS to guide troops through sand storms during the first Gulf War. In 1995, GPS became a household name after Air Force Capt. Scott F. O'Grady used his handheld unit to guide rescuers to his position after his jet was shot down over Bosnia-Herzegovina.

Since then, GPS has revolutionized warfare. GPS is used to direct the drones seeking out insurgents in Afghanistan, and has made "smart bombs" so accurate that they can be dropped from 40,000 feet and still land within 10 feet of their target.

The Pentagon operates and controls the GPS satellite system used in every country around the world. Until 2000, it deliberately degraded the signals that could be read by civilian devices.

Commercial applications soared in 2000, when President Clinton ordered the Pentagon to stop manipulating the signals.

Worried that the U.S. could flip the switch and shut off GPS capability to the rest of the world, several countries are developing their own satellites. The European Union, China and Russia are spending billions of dollars on their versions.

Commercial applications, meanwhile, continue to multiply.

Farmers use GPS on tractors to plant seeds in straight rows without overlapping. Oil-exploration firms use it to zero in on offshore oil fields that lay thousands of feet below the surface on the ocean floor.

The number of subscribers to such services is expected to balloon to at least 15 million this year, up from 100,000 six years ago, according to Frost & Sullivan, a San Antonio research firm. "That's not including the hundreds of millions of people who get the signals for free on applications through their cellphones," said Frost analyst Daniel Longfield.

"GPS has truly become the lighthouse of the world," Parkinson said. "It's just remarkable how the system has evolved over the past 30 years. It'll be just as interesting to see what will come in the next 30."

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