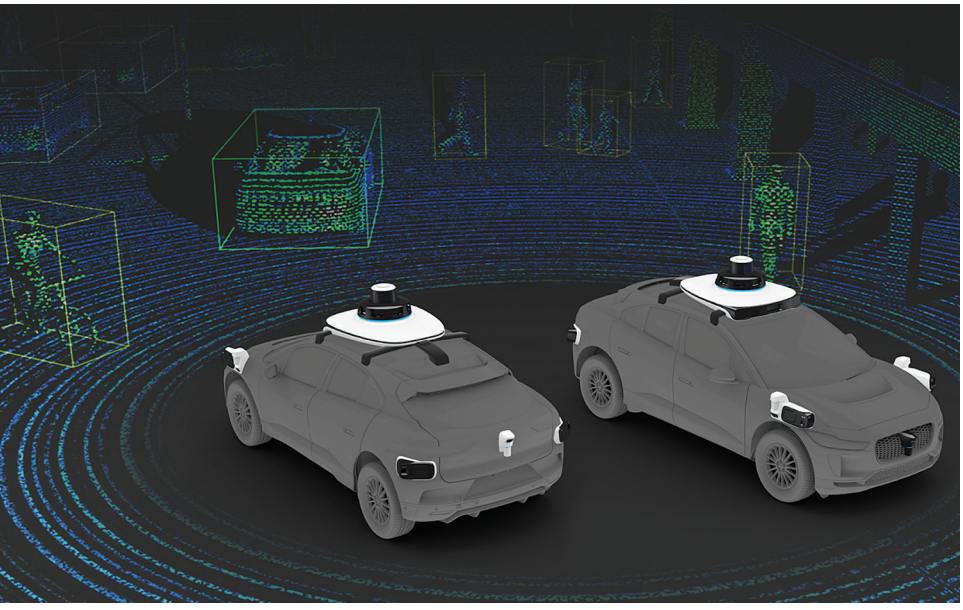

STOP AND GO: Waymo temporarily suspended trials of its self-driving cars but has released large data sets that developers can use to help improve its algorithms in the meantime.

THE ROAD AHEAD FOR SELF-DRIVING CARS

The AV industry has had to reset expectations, as it shifts its focus to Level 4 autonomy

In March, because of the coronavirus, self-driving car companies, including Argo, Aurora, Cruise, Pony, and Waymo, suspended vehicle testing and operations that involved a human driver. Around the same time, Waymo and Ford released open data sets of information collected during autonomous-vehicle tests and challenged developers to use them to come up with faster and smarter self-driving algorithms.

These developments suggest the self-driving car industry still hopes to make meaningful progress on autonomous vehicles (AVs) this year. But the industry is undoubtedly slowed by the pandemic and facing a set of very hard problems that have gotten no easier to solve in the interim.

Five years ago, several self-driving car companies including Nissan and Toyota promised self-driving cars in 2020. Lauren Isaac, the Denver-based director of business initiatives at the French self-driving vehicle company EasyMile, says AV hype was "at its peak" back then—and those predictions turned out to be far too rosy.

Now, Isaac says, many companies have turned their immediate attention away from developing fully autonomous Level 5 vehicles, which can operate in any conditions. Instead, the companies are focused on Level 4 automation, which refers to fully automated vehicles that operate within very specific geographical areas or weather conditions. "Today, pretty much all the technology developers are realizing that this is going to be a much more incremental process," she says.

For example, EasyMile's self-driving shuttles operate in airports, college campuses, and business parks. Isaac says the company's shuttles are all Level 4. Unlike Level 3 autonomy (which relies on a driver behind the wheel as its backup), the backup driver in a Level 4 vehicle is the vehicle itself.

"We have levels of redundancy for this technology," she says. "So with our driverless shuttles, we have multiple levels of braking systems, multiple levels of lidars. We have coverage for all systems looking at it from a lot of different angles."

Another challenge: There's no consensus on the fundamental question of how an AV looks at the world. Elon Musk has famously said that any AV manufacturer that uses lidar is "doomed." A 2019 Cornell research paper seemed to bolster the Tesla CEO's controversial claim by developing algorithms that can derive from stereo cameras 3D depth-perception capabilities that rival those of lidar.

However, open data sets have called lidar doomsayers into doubt, says Sam Abuelsamid, a Detroit-based principal analyst in mobility research at the industry consulting firm Navigant Research.

Abuelsamid highlighted a 2019 open data set from the AV company Aptiv, which the AI company Scale then analyzed using two independent sources: The first considered camera data only, while the second incorporated camera plus lidar data. The Scale team found camera-only (2D) data sometimes drew inaccurate "bounding boxes" around vehicles and made poorer predictions about where those vehicles would be going in the immediate future—one of the most important functions of any self-driving system.

"While 2D annotations may look superficially accurate, they often have deeper

WAYMO

inaccuracies hiding beneath the surface," software engineer Nathan Hayflick of Scale wrote in a company blog about the team's Aptiv data set research. "Inaccurate data will harm the confidence of [machine learning] models whose outputs cascade down into the vehicle's prediction and planning software."

Abuelsamid says Scale's analysis of Aptiv's data brought home the importance of building AVs with redundant and complementary sensors—and shows why Musk's dismissal of lidar may be too glib. "The [lidar] point cloud gives you precise distance to each point on that vehicle," he says. "So you can now much more accurately calculate the trajectory of that vehicle. You have to have that to do proper prediction."

So how soon might the industry deliver self-driving cars to the masses? Emmanouil Chaniotakis is a lecturer in transport modeling and machine learning at University College London. Earlier this year, he and two researchers at the Technical University of Munich published a comprehensive review of all the studies they could find on the future of shared autonomous vehicles (SAVs). They found the predictions—for robo-taxis, AV ride-hailing services, and other autonomous car-sharing possibilities—to be all over the map. One forecast had shared autonomous vehicles driving just 20 percent of all miles driven in 2040, while another model forecast them handling 70 percent of all miles driven by 2035.

So autonomous vehicles (shared or not), by some measures at least, could still be many years out. And it's worth remembering that previous predictions proved far too optimistic.

—MARK ANDERSON

POST YOUR COMMENTS AT
spectrum.ieee.org/selfdriving-may2020

WANTED: A FALLBACK FOR GPS

The U.S. government seeks tech that could step in if its global satellite fleet were to fail

The U.S. Global Positioning System fleet of satellites provides critical data for navigation apps, banks, power grids, and other commercial and government infrastructure. But for the past decade, it has operated without a safety net, with no backup system in place. Now, two U.S. federal agencies want to change that, and they could select one or more alternatives by September.

Later this month, the U.S. Department of Transportation (DOT) is due to deliver the results of a recent demonstration of potential GPS backup technologies to the National Executive Committee for Space-Based Positioning, Navigation, and Timing (PNT). The committee, which is cochaired by deputy secretaries of the U.S. Departments of Transportation and Defense, is expected to use the findings to announce next steps sometime in August. Those steps may include selecting one or more technologies and issuing a request for proposals for companies to develop them.

Eleven finalists participated in the two-week, mid-March demo, in which they showed how their respective PNT systems would perform if GPS went down because of jamming, spoofing, or other problems. The companies, which tested both space- and ground-based systems and include venture-backed startups and industry old-timers, were awarded a total of approximately US $2.5 million to prepare for the demos.

Tests were split between NASA's Langley Research Center in Hampton, Va., and a 155-acre test range operated by the DOT and the John A. Volpe National Transportation Systems Center at Joint Base Cape Cod in Buzzards Bay, Mass. The test portion was finished by the time states began issuing orders to shelter in place because of COVID-19; however, a 20 March VIP day that would have concluded the demo at Joint Base Cape Cod was canceled because of the outbreak. The DOT did not respond to a request for comment, but it has not indicated that the timeline for its decision would be affected by ongoing efforts to stem the pandemic.

A GPS fail-safe has been a long time coming. A previous backup was built on the Loran-C radio navigation system that had been in use in some form since World War II, but it was determined to be obsolete and was dismantled in 2010. Four years later, lawmakers and federal agencies began investigating a new alternative. Although Congress passed laws in 2017 and 2018 authorizing tests of backup options, red tape and lack of funding delayed activity until last year, when a newly appointed DOT assistant secretary for research and technology fast-tracked funding for a test.

JUST IN CASE: This e-Loran antenna owned by Hellen Systems can fit inside a shipping container for easy transport.

HELLEN SYSTEMS