Quarterly AV Testing Report
2nd Quarter 2020

Background

We are committed to designing for people; for families that need to get their children to school safely; for elderly passengers who need continued access to mobility; and for urbanites who, more than ever, have a choice in how they get around cities. We know that self-driving vehicles have the potential to bring vast benefits to humanity: increased mobility, fewer traffic-related deaths, and a greener planet. But the only way to fulfill these promises of tomorrow is to build trust in the technology today. We believe that when openness and collaboration are demonstrated, trust follows.

Our team's expertise in autonomous driving can be traced from our R&D roots at MIT and Carnegie Mellon University, where we showcased our autonomous technology in the DARPA Grand Challenge and DARPA Urban Challenge, to our present-day commercial operation in Las Vegas, which has provided more than 100,000 self-driving rides to members of the public. We are proud to report that our attention to safety has

extended into our real-world operations; we have driven over 1,000,000 miles in complex city environments around the globe while maintaining a record of zero at-fault incidents.

Today, our global team—spanning North America and Asia—is dedicated to delivering safe and reliable production-ready SAE Level 4 robotaxis that will make roads safer and improve mobility worldwide. As we advance the technology, our people-first ethos will ensure that safety, security, and privacy are embedded in every step.

Since the beginning of the year, a lot has changed, both in our Boston office and around the world. Like everyone, we have been heavily focused on COVID-19. In early January, we banned all business travel and, weeks ahead of government orders, shut down all our offices, and went entirely remote. Learning from the early cases in Singapore, we quickly adopted best practices and applied them throughout our

best practices and applied them throughout our business. Our priority remains the safety of our employees and our community. We are proud of the safety protocols we have put in place to protect them as we have partially reopened some offices. We remain vigilant and continue to monitor guidance from Federal, State, and local public health officials.

Testing activity

A focus of ours over the last quarter has been on performance around suburban elements. We are in the process of modifying our test track to include a number of new elements common in suburban driving such as driveways, speed bumps, and a variety of low-speed intersections. These elements will be validated on our test track prior to on-road testing across all sites (Boston, Singapore, Pittsburgh, and Las Vegas).

Operational Design Domain (ODD)

Our vehicles are designed to operate in low-speed (<35 MPH), urban environments in a variety of conditions. We continuously validate all vehicle performance and behavior changes to our AVs in simulation, then in a closed-course setting before operating them on public roads. To date, we have experience testing on public streets with a variety of road actors, including heavy vehicle traffic, cyclists, and pedestrians. Additionally, we have operated our AVs safely in daytime and nighttime, and in windy, rainy, and snowy conditions both in closed-course and public road environments.

Amount of Testing

Our testing occurs primarily during regular business hours (Monday through Friday, 9 AM-5 PM). As mentioned above, this testing includes specialized testing in closed-course and data gathering in the Seaport / South Boston area.

Takeover procedure

Safety drivers take over manual control in any situation in which they feel uncomfortable or unsafe. Planned takeovers are also done when finishing a mission or when approaching situations that are not within the outlined ODD.

During the Second Quarter, our safety drivers took over manual control of our AV's in the following situations:

- When emergency vehicles were in active operation (e.g., sirens and lights activated) in the roadway;

- When law enforcement officers were manually directing traffic in intersections through which our AV's were traveling;

- In certain situations in which construction vehicles were obstructing our lane of travel;

- In certain situations in which oncoming vehicles or bicycles violated lane boundaries;

- In certain situations in which weather conditions deteriorate rapidly; and,

- When other vehicles were exhibiting erratic behavior near our AV's.

A safety driver's decision to take over manual control in a given situation does not necessarily indicate that continued autonomous operation in those situations would be unsafe. Because we instruct our safety drivers to err on the side of caution, we expect that takeovers will occur in many situations in which the AV would have handled the situation without incident. We are continuously improving our AV software, and we are confident that our AVs will be able to handle each of these situations without a takeover after further development.

Description of ADS system failures

We did not experience any unanticipated failures or disruptions while driving in autonomous mode. As we explain above in greater detail, in specific traffic scenarios, our safety drivers take over manual control because of known limitations of the current state of AV software.

Goals for future testing

As we continue to increase the safety and capabilities of our AV software, we are also exploring the additional product capabilities needed to operate a robotaxi fleet. We are currently going through design and testing process for features such as best practices for autonomous pickup and drop-offs and more passenger-friendly user interfaces for controlling and understanding AV behavior. These features are crucial to our commercial operations and help us to gain the trust of the public, potential partners, and governing agencies.

Our current development plan has us expanding the amount of higher speed testing (around 35 mph), in increasingly complex urban environments. On top of existing scenarios, we plan to layer in public testing during moderate rain, at night, or in low-light situations. These are all tests we have undertaken in the past, however, we plan to increase their proportion within our overall testing mix.

Insights

Before the outbreak of COVID-19, our testing protocols called for a Vehicle Operator (VO) and Test Engineer (TE) to be seated side-by-side in the vehicle. To achieve social distancing, we moved our TE to the back row, with communication

through headsets and mics. Windows were lowered and air was not circulated in the vehicle.

We have since added clear partitions between the driver and passenger seat, and we're now exploring how this could be adapted for future passenger service and ride-sharing.

In addition, we carried out COVID-related user experience research. 'Seeing is believing' was a key theme, with respondents communicating the importance of experiencing the cleaning and sanitation process, rather than just the outcome. Our product team is exploring ways to deliver this without negatively affecting trip times or other service metrics.

Feedback for municipal and state transportation engineers, planners, and policymakers

AVs are attractive, in part, because they're law-abiding: they don't speed, they don't park illegally, and they don't text and drive. Because laws differ significantly across the country, however, (and even within individual states), establishing the protocols that AVs are to follow in any particular location is challenging and can vary by location. This could be streamlined if traffic laws and systems, where possible, were standardized.

To be clear, we are not recommending that cities and states all adopt the same laws. We believe that local management of our streets is crucial to creating vibrant cities. However, if definitions, taxonomy, and organization were more aligned across jurisdictions, it would make AV deployment smoother.

This is an established concept. For years, the National Committee on Uniform Traffic Laws and Ordinances produced a Uniform Vehicle Code (last updated in 2001). It proposed that jurisdictions could adopt the code and modify it based on local requirements. For example, Massachusetts may have winter driving requirements in the amendment, whereas Florida would not. Another example of uniform code from outside of transportation is the Uniform Commercial Code, that provides a consistent structure to business operations across states.

A uniform structure would provide more accessible laws to drivers as much as it would for AV developers.