



QUARTERLY AV TESTING REPORT

3rd QUARTER 2019

BACKGROUND

Aptiv is a global technology company that develops safer, greener and more connected solutions enabling the future of mobility. Aptiv's Autonomous Mobility team is focused on developing and commercializing autonomous vehicles and systems that enable point-to-point mobility via large fleets of autonomous vehicles (AVs) in challenging urban driving environments. With talented teams working across the globe, from Boston to Singapore, Aptiv is the first company to deploy a commercial, autonomous ride-hailing service based in Las Vegas. Today, we have provided over 75,000 public passenger rides, with 98% of passengers rating their experience 5 out of 5 stars. At Aptiv, we believe that our mobility solutions have the power to change the world.

nuTonomy, which was acquired by Aptiv in 2017 and is now Aptiv Autonomous Mobility, began testing AVs on the public roads in Boston in January 2017 under a test plan with the City of Boston. Later in 2017, Aptiv acquired nuTonomy to complement and grow our existing AV technology program. This report covers the joint progress of Aptiv Autonomous Mobility and our nuTonomy affiliate during the Third Quarter of 2019.

In September 2019, Aptiv and Hyundai Motor Group announced that the two companies would enter into a joint venture focused on autonomous mobility. This transaction is expected to close in the first half of 2020. By joining resources with Hyundai Motor Group, our team will advance development of production-ready autonomous driving systems for commercialization of Level 4 and 5 self-driving technologies. Hyundai will contribute \$1,600,000 in cash at the close of the transaction and vehicle engineering support valued at \$400,000,000. Aptiv will contribute 700 employees across four (4) technical centers in Boston, Pittsburgh, Las Vegas, Santa Monica and Singapore. The new entity will remain focused on autonomous mobility through the development of key intellectual property and systems for Level 4 and 5 AVs.

Outside of this significant corporate milestone, our AV testing has continued on the Chrysler Pacifica PHEV platform in Boston. We continue to complete a mix of simulation, closed course, and public road tests on this vehicle as we work toward our long-term goal of deploying a driverless vehicles. In addition to this technical work, we spent time engaging with local community members, including the First Responder community and multiple student groups, to ensure that AVs are a complementary part of Boston's mobility ecosystem.

SUMMARY

Miles Driven

As we stated in our Report in the Third Quarter of 2017, Aptiv has exceeded the 600 autonomous miles required for Phases B1, B2, C1, and C2 of the Test Plan. As always, it is important to note that our autonomous driving in Boston represents a small fraction of accumulated autonomous mileage. Globally, Aptiv has completed over one million autonomous miles across four major markets and two countries. While our footprint in Boston is small, our autonomous driving in Boston is high leverage: the complexity of road conditions and the density of vehicles, pedestrians, cyclists, and other road users accelerates our research.

Locations Driven

During the Third Quarter, we operated our AV's in autonomous mode on streets in the Seaport and in the periphery of South Boston. Specific roadways include: A Street, Black Falcon Avenue, B Street, Bond Drive, Boston Wharf Road, Congress Street, Courthouse Way, Cypher Street, D Street, Dorchester Avenue, Drydock Avenue, E Street, Fan Pier Boulevard, Fargo Street, Harbor Shore Drive, Northern Avenue, Pier Four Boulevard, Richards Street, Seaport Boulevard, Sleeper Street, Summer Street, Tide Street, West 1st Street, West 2nd Street, and various small connector streets. Additionally, we operated our AVs in manual mode for data collection and mapping purposes throughout the remainder of the Seaport and South Boston neighborhoods. We also conducted testing in our closed-course facility in the Boston area.

Crash Reports

We have not produced any crash reports, because our AV's have not been involved in any collisions during our testing in Boston.

Failures with Autonomous Mode

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

Takeovers

Aptiv's safety drivers take over manual control in any situation in which they feel uncomfortable or unsafe. During the ThirdQuarter, our safety drivers took over manual control of our AV's in the following situations:

1. when emergency vehicles were in active operation (e.g., sirens and lights activated) in the roadway;
2. when law enforcement officers were manually directing traffic in intersections through which our AV's were traveling;
3. in certain situations in which construction vehicles were obstructing our lane of travel;
4. in certain situations in which oncoming vehicles or bicycles violated lane boundaries;
5. in certain situations in which weather conditions deteriorate rapidly; and,
6. 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.

LEARNING

What We Have Learned

With the support of the City of Boston and MassDOT, we had the privilege of hosting First Responders from the Greater Boston community at our facility in September. This served as a unique opportunity to collaboratively design the future interactions between AVs and First Responders. As the number of AVs on our public roadways grows, it is important that (1) AVs can respond to active First Responder vehicles and (2) First Responders can safely interact with disabled AVs. While perfecting these interactions will take time, our initial sessions with First Responders yielded a number of important learnings.

As a starting point for our discussions, we sought to educate the First Responders about the building blocks of AV technology and our testing program in Boston. Specifically, we focused on those technologies that differentiate an AV from a conventional vehicle a First Responder might encounter. Second, we sought to learn from the First Responders in attendance about their interactions with conventional vehicles and how an AV might be designed to avoid common difficulties they encounter in the field. Lastly, we gave a detailed overview about the best methods for First Responders to engage with our vehicles when they encounter them on the roadways.

While many of our learnings were nuanced and situational, we had some key general learnings from our discussions with First Responders as well:

- General training in dealing with high voltage systems, specifically for hybrid and electric vehicles, is critical to safe response protocols
- Vehicles should be clearly marked and equipped with easy-to-find and easy-to-read instructions for working with all AV specific systems
- First Responders should have simple, consistent, and clear mechanisms to ensure all autonomous and conventional driving controls are disengaged when approaching a disabled vehicle

At Aptiv, we are committed to ensuring that on-demand driverless vehicles benefit cities and their citizens. To do this, we will deploy self-driving cars in close collaboration with government officials, the communities that use automated transportation, and the employees who help keep our cities safe – including our first responders. We want to thank these civil servants for all that they do, and take a moment to reinforce our commitment to ensuring they have a seat at the table in defining the future of self-driving mobility.

As always, we thank Governor Baker, Mayor Walsh, Secretary Pollack, and their teams for their continued support of our AV testing in Boston.

IMAGES



© 2019 Aptiv

One of our Autonomous Vehicles out at our Suffolk Downs test track



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attendees listen as a member of Boston Fire Department provides a comment during our First Responders Workshop in collaboration with MassDOT and the City of Boston



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First Responders discuss content from the workshop in front of one of our Autonomous Vehicles