



## QUARTERLY AV TESTING REPORT

2<sup>nd</sup> QUARTER 2018

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## BACKGROUND

nuTonomy develops autonomous vehicle (AV) technology. Since January 2017, we have been testing our AVs on the public roads in Boston. In November, we joined forces with Aptiv, a global mobility technology company. nuTonomy and the City of Boston have agreed to a Test Plan, which asks nuTonomy to report on our AV testing quarterly. This Report covers our progress during the Second Quarter of 2018.

On June 15 of this year, the City approved nuTonomy to move to Phase D of our Test Plan. Phase D authorizes nuTonomy to test our AVs “within the City of Boston on City and MassDOT owned or managed roadways . . . with a speed limit at 35mph or less.” Phase D represents a significant expansion of our testing area—from a geography of approximately one square mile to approximately 49 square miles.

nuTonomy plans to expand our AV testing across the city carefully and incrementally. The first step of expanding AV operations to a new area is to collect data for the specialized, detailed maps that our AV software uses. We gather map data using the same vehicles, and some of the same sensors, that we use for autonomous operation. Consequently, it may appear to bystanders observing our AVs during data collection that we are operating in autonomous mode, even though we are in manual mode.

In the Second Quarter, we collected map data on selected streets in South Boston and in the northwestern corner of the Seaport. Our primary goal is to develop a testing area with a broad range of different traffic scenarios within our AV’s Operational Design Domain. We would also like to expand the area available for potential passenger demonstrations of AV technology. We are currently in the process of refining those maps and will gradually begin autonomous operation on a subset of the roads that we have mapped.

During the Second Quarter, we also continued to test new features on our AV software in autonomous mode in our previously approved testing geography. We supported our public road testing with closed course testing in Devens, Massachusetts. We use the Devens facility primarily for vehicle safety and maneuver testing and for training our new safety drivers and test engineers.

Near the end of the Quarter, on June 24, nuTonomy participated in a ceremony honoring the signing of Massachusetts’ Regional Memorandum of Understanding for AV testing. We were proud to welcome Governor Baker and local mayors into our AVs for a short autonomous ride. We look forward to expanding AV testing throughout the Commonwealth in the coming years.



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## SUMMARY

### Miles Driven

As we stated in our Report in the Third Quarter of 2017, nuTonomy 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 the total amount of our autonomous miles driven globally, due to the larger fleet, operations team, and testing area we have available in Singapore. But we view our Boston testing as high leverage each mile on the Seaport's complex and traffic-dense roadways provides significant technical feedback for developing our AV software.

### Locations Driven

During the Second Quarter, our public road operations focused on three tasks:

1. autonomous driving for research and development purposes in the previously authorized sections of the Seaport;
2. mapping of the newly authorized section of the Seaport—the northwest corner; and
3. mapping of certain sections of South Boston.

We operated our AVs in autonomous mode on Black Falcon Avenue, Congress Street, Dorchester Avenue, Drydock Avenue, Northern Avenue, Summer Street, Tide Street, and various small connector streets. We operate in manual mode on certain streets in the Seaport owned by Massport.

We conducted mapping in newly authorized areas in the Seaport, including Bond Drive, Boston Wharf Road, Courthouse Way, Fan Pier Boulevard, Harbor Shore Drive, Liberty Drive, Marina Park Drive, parts of Northern Avenue, Pier Four Boulevard, parts of Seaport Boulevard, Sleeper Street.

We also conducted mapping in South Boston, including A Street, Atlantic Street, B Street, C Street, Columbia Road, D Street, Dorchester Avenue, Dorchester Street, E Street, East Broadway, East 1<sup>st</sup> Street, East 4<sup>th</sup> Street, Emerson Street, G Street, Gates Street, I Street, K Street, L Street, National Street, Old Colony Avenue, Pappas Way, Preble Street, Telegraph Street, Thomas Park, Tudor Street, West Broadway, West 1<sup>st</sup> Street, West 2<sup>nd</sup> Street, West 7<sup>th</sup> Street, West 8<sup>th</sup> Street, and William J. Day Boulevard.

Additionally, we tested our AVs in a closed course environment at the Devens facility.



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## SUMMARY

### **Crash Reports**

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

### **Failures with Autonomous Mode**

We did not experience any unanticipated failures with 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.



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## SUMMARY

### Takeovers

nuTonomy's safety drivers take over manual control in any situation in which they feel uncomfortable or unsafe. During the Second Quarter, our safety drivers took over manual control of our AVs 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 AVs were travelling;
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; and,
5. when other vehicles were exhibiting erratic behavior near our AVs;

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.



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## LEARNING

### What We Have Learned

As this Report has explained, we have been operating in three environments during the Second Quarter: the Seaport (for AV operation and some mapping), South Boston (for mapping), and Devens (for closed course testing). Each area generated some new learning.

In the Seaport, we adapted our AVs to the variety of construction projects that started in the spring. Part of the challenge is that some of these changes are temporary—traffic directed by a police officer or with traffic cones around a section of roadway while construction vehicles pass; others are semi-permanent—new lane markings or jersey barriers to avoid a construction site; and still others are permanent—new roadways opened and others closed after construction.

In South Boston, we observed a set of novel roadway conditions during mapping. The most notable was the varying width of the roadways. Some South Boston streets are extremely narrow. Others have a lane-and-a-half in each direction. There is also variation in how parked cars are oriented into the roadway, which affects traffic patterns in the roadway and can occlude objects.

At the Devens facility, our challenge has been of a different sort: roadways with overgrown vegetation and the occasional deer and squirrels. nuTonomy has, to date, been focused on urban driving in Boston and Singapore. We came to Devens simply to find a closed course environment for safety and maneuver testing. What we encountered was our first exposure to rural roadways.

This Quarter, we would like to give a special thanks to Mayor Walsh, Commissioner Fiandaca, the Boston Department of Transportation, and the Mayor's Office of New Urban Mechanics for their expansion of our testing area as part of Phase D of the Test Plan. We would also like to thank Governor Baker and the Massachusetts Department of Transportation for supporting the Regional MOU process and continued AV testing in the Commonwealth.

# IMAGES



One of our AVs at Castle Island



Governor Baker at the signing of the regional MOU



Our AV collecting mapping data in South Boston