Vehicle Safety Technology Report

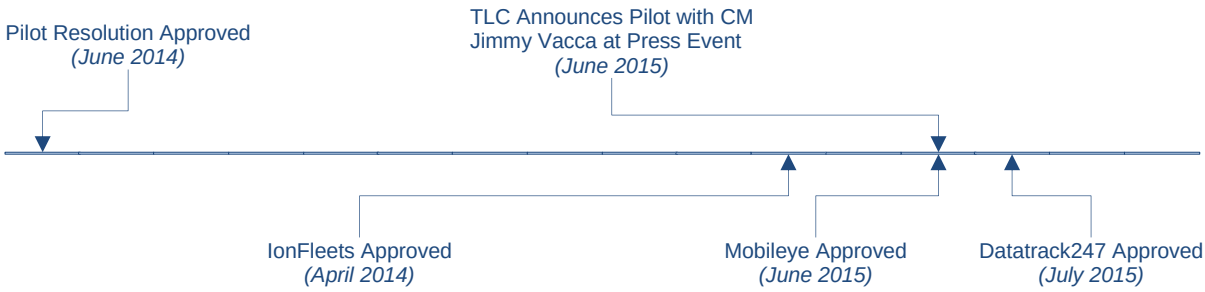
November 2015

Background and Introduction

In February 2014, Mayor Bill de Blasio released the Vision Zero Action Plan, the goal of which is to end traffic-related deaths in New York City. As the regulator of nearly 80,000 licensed vehicles that travel on New York City streets, the Taxi and Limousine Commission has a central role in achieving this goal. During the first four months of this pilot (April through September of 2015), there have been, on average, 3,000 crashes involving a TLC-licensed vehicle per month. Thus, as a part of Vision Zero, TLC is undertaking a range of safety-related initiatives, including the Vehicle Safety Technology ("VST") Pilot. During the VST Pilot, TLC is studying the use of innovative technologies that may improve the driving habits of TLC licensees. Examples of these technologies include electronic data recorders (or "black boxes"), driver alerting/collision avoidance systems, speed governors, and analytics platforms. TLC intends to use the findings of the Pilot to inform any regulation that is adopted surrounding the use of these innovative technologies.

The Commission unanimously adopted the VST Pilot Resolution in June 2014, and the yearlong program officially began in April 2015, when the TLC approved the first Participant. TLC has subsequently approved two more Participants and continues to work with other interested parties. This brings the total number of participating vendors who provide the technology to three and the number of participating vehicles to 33 for this report.

Pilot Timeline



This report is the first of three on the VST Pilot, as required by the authorizing resolution, and will discuss, among other things, the impact of the piloted technologies on driver behavior and collision rates, the challenges of implementing such technologies, and the extent to which such technologies affect the business costs of TLC licensees.

Current Pilot Participants

In this report, "Participants" refers to companies who provide Vehicle Safety Technologies under the Pilot. Currently, there are three Participants: Mobileye, IonFleets, and Datatrack247. The TLC licensees with whom the Participants are working during the Pilot are referred to as "TLC Partners." Table 1 shows a summary of the kinds of technologies each Participant is providing under the Pilot and who their TLC Partners are.

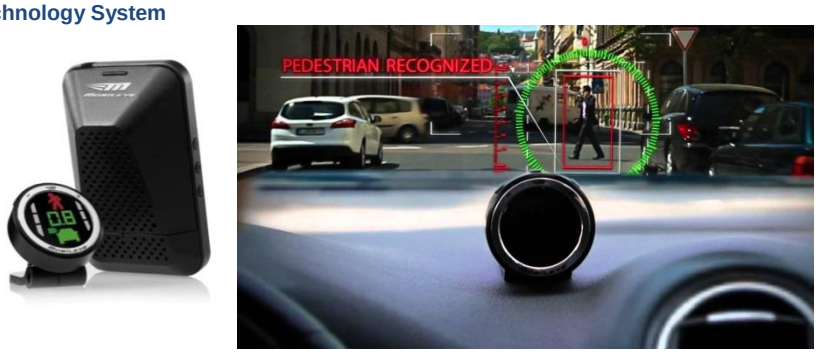
Table 1: Summary of Participants

		IonFleets	Mobileye	Datatrack247
	Date Started	April 7th, 2015	May 22nd, 2015	July 31st, 2015
Technology	Black Box	✓	✓	✓
	Driver Alerts	✓	✓	✓
	Cameras	✓		
	Analytics Software	✓	✓	✓
Vehicles Participating at Publication	Yellow	2	13	
	SHL	2		
	FHV	2	2	12
	TLC Partners	▪ NYC Taxi Group ▪ Holyland Associates ▪ New York Limo & Car Service	Luxury One	Wakefield LSG Maintenance Corp.

Mobileye

Mobileye is a publicly-traded company that sells a driver alert system directly to vehicle manufacturers or as an aftermarket solution for fleets or vehicle owners. In the Pilot, Mobileye is providing its aftermarket solution to a fleet of primarily yellow taxis. Their technology consists of a forward-facing sensor mounted to the windshield, a small LED screen that sits on top of the dashboard, and a motor mounted underneath the driver's seat. The sensor is used to continuously monitor and analyze road conditions, identifying situations that may be dangerous to the driver. If, for instance, the system senses that the driver is departing from a lane without signaling, or following a vehicle too closely, it will provide an auditory and visual alert through the device mounted on the dash, and will vibrate the driver's chair with the motor mounted underneath it. During the Pilot, Mobileye is including a black box in its system. The black box is used to help prove the concept of the Mobileye technology, which would not otherwise generate data or reports for TLC's analysis. In addition to the raw data reported by the black boxes, TLC staff also receives reports from Mobileye, which shows the company's analysis of behavior over time for drivers who are using the technology.

Figure 1: Mobileye Technology System



IonFleets

IonFleets is a service provider—it bundles and provides services offered by several other companies for its customers to use as one packaged service. For the VST Pilot, IonFleets has provided its TLC Partners with a technology system that includes three cameras (one driver-facing, one forward-facing and one rear-facing), Mobileye's alerting system (as described above), and a black box. The three different streams of information created by these technologies are tied together in a software platform, which allows TLC staff and fleet managers to review footage of drivers operating the vehicle, or to see reports on their drivers' driving habits.

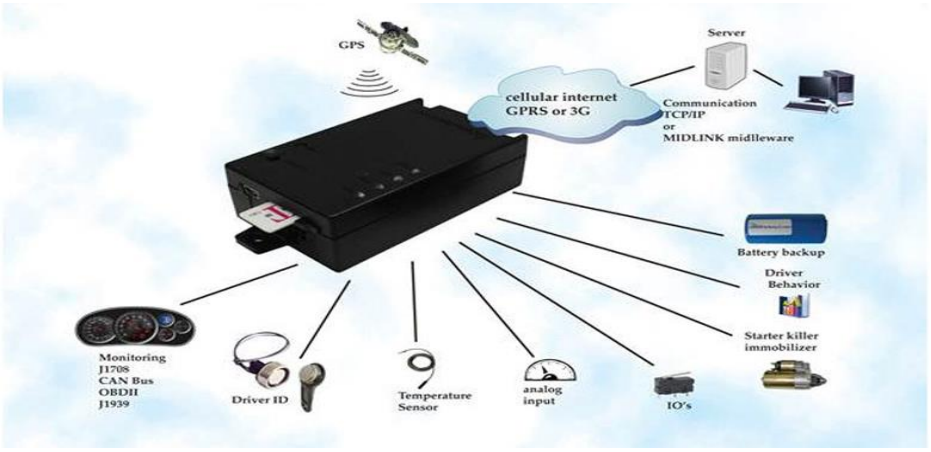
Figure 2: IonFleets Technology System

Datatrack247

For the Pilot, Datatrack247 is providing a technology solution that includes a black box and an analytics software platform. The black boxes Datatrack247 uses, however, can also trigger the seat belt alarm in the vehicle when it senses erratic driving.

The software platform that Datatrack247 provides its customers is also used to dispatch trips, and is used in some cases to generate trip logs to submit to TLC per the new trip record reporting requirements for some TLC-licensed bases.

Figure 3: Datatrack247 Technology System

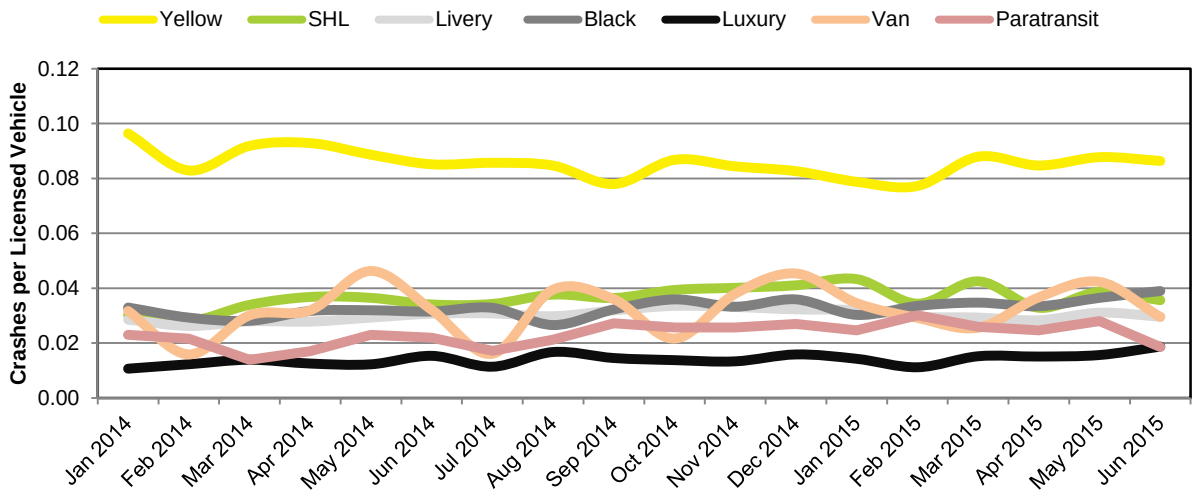


Vehicle Safety Technology's Effect on Collision Rates

The chart below shows crash rates for TLC-licensed vehicles since January 2014. Crashes were broken out by industry type and divided by the imputed number of vehicles licensed in those industries in each month. Note that while yellow taxis may immediately appear to crash at a higher rate than other TLC-licensed vehicles, this chart does not take into account the amount of time or miles a particular vehicle spends on the road, possibly over-representing taxis, which are often on the road around the clock (they are typically operated in shifts and are likely to have two drivers driving two shifts in a given day).

For types of vehicles that are currently participating in the Pilot—yellow taxis, Green Taxis, liveries, black cars and luxury limousines—crash rates tend to stay within bands over time. These crash rates provide a baseline to which crash rates of vehicles participating in the Pilot can be compared. Because of the small sample size available for the first four months of the pilot, TLC did not examine the specific crash rates for participating vehicles and will re-assess as more data is collected.

Figure 4: Crashes Involving TLC-Licensed Vehicle per Vehicle of Its Type



Vehicle Safety Technology's Effects on Driver Behavior

There are two primary sources of information TLC staff will use during the Pilot to gauge the effect VSTs have on driver behavior. The first will be the reports and data generated by the technologies being used in the Pilot and the second will be from New York City Police Department (NYPD) and TLC databases of issued summonses.

TLC is working with the Participants to develop reports and datasets that go beyond the level of detail normally provided to a customer. As these data streams are developed, TLC intends to compare them to other sources of information to which TLC already has access.

Driver Alert Reporting

All three companies use one of two types of driver alerts to try to improve driver safety. The Mobileye device, in use by Mobileye and IonFleets, uses a forward-facing sensor to identify objects in its field of vision such as other vehicles, pedestrians, or painted lines. The device continuously analyzes the trajectory of those objects and the vehicle's relation to them. If the system senses that the vehicle will collide with one of those objects, it will create an audio, visual, and haptic[1] warning, designed to give the driver enough time to react and avoid or mitigate a collision. These types of alerts are meant to combat driver inattention and fatigue.

Datatrack247 uses an accelerometer-based sensor—similar to the ones found in smart phones that detect movement—which alerts the driver after it has sensed erratic driving behavior. For instance, if a driver accelerates quickly, the black box device will cause the car to emit a loud beeping noise to discourage the driver from repeating that behavior. These types of driver alerts do not necessarily provide immediate collision avoidance assistance, but focus on discouraging drivers from repeating erratic and dangerous driver behaviors. Table 2 shows the various warning systems in use by the companies.

Table 2: Types of Driver Alerts

	Mobileye*	Datatrack247's Black Box
Sensor	Forward-facing camera	Accelerometer
Object Detection Capabilities	Can detect other vehicles, pedestrians, and painted lines in line-of-sight	N/A
Triggering an Alert	Actively performs calculations based on trajectory of sensed objects and vehicle to and anticipate potential collisions	Monitors g-forces imposed on vehicle, alerting driver when they exceed a preprogrammed threshold
Warning Types	Creates an audio, visual, and/or haptic warning	Creates audio warning

*Also used in the IonFleets solution

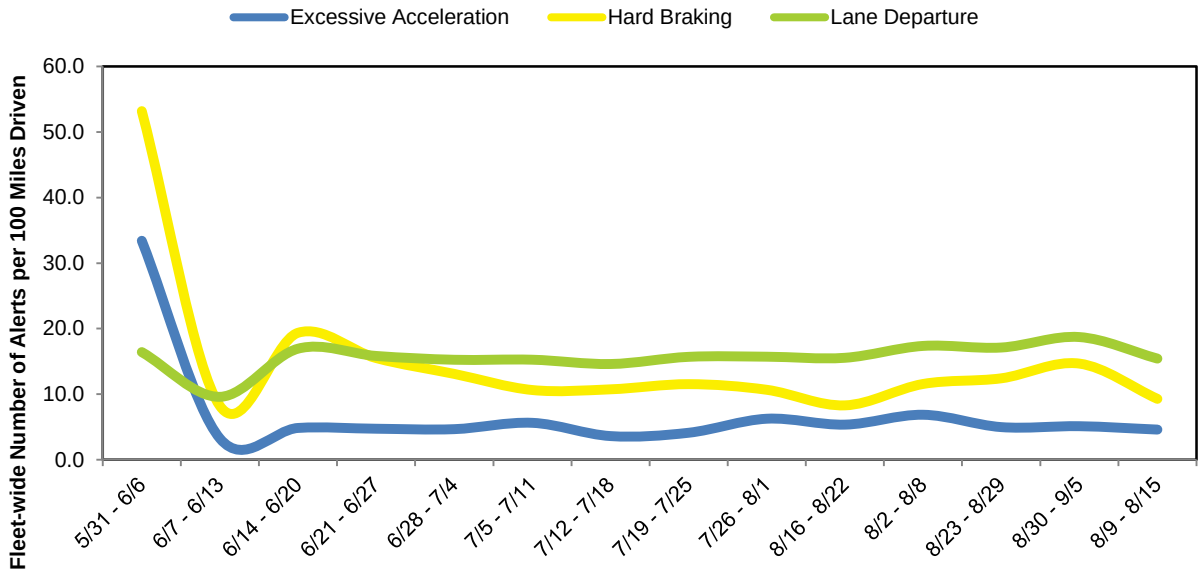
Analysis of Datatrack247's Alerts

Datatrack247 provided TLC with alert data for the months of May through August. The frequencies of the top three alerts during that time are displayed in the chart on the following page. he data are normalized by the number of miles the participating vehicles drove. Specifically, the graph shows the aggregate number of alerts received per 100 miles driven by the vehicles.

During the first week of data collection, Datatrack247 turned alerts to silent, so that the driver would not know when the device recorded elevated g-forces. The amount of "alerts" shown at that time—which were recorded, but not conveyed to the driver—is taken to show the natural driving habits of the participating drivers. In the second week of data collection, all three of the alerts in the chart below were turned on, and, collectively, alerts dropped by 80%. The number of alerts remained at this level for the remainder of the analysis period.[2] This suggests that the alerts may have had an impact on driver behavior and prevented excessive acceleration, hard braking, and lane departures as specifically measured by this system.

[1] In this case, haptic warnings are vibrations felt by the driver.
[2] During the final 10 weeks of the analysis period, the total number of received alerts stayed within ± 16% of the average.

Figure 5: Datatrack247 Driver Alerts



Analysis of Mobileye Alerts

Mobileye's TLC Partners have not seen as dramatic a drop in alerts. Alerts received by Mobileye's TLC Partners are shown in the graph below, normalized per 100 miles traveled, as above. One possible explanation for this is the composition of the fleet, which comprises primarily yellow taxis. Since many yellow taxicabs have multiple drivers per vehicle in a given week, enough time has not passed, nor have enough vehicles in this particular fleet been equipped with the technology, to ensure continuity in drivers receiving alerts for every shift. Reviewing alert data alongside crash and summons histories for these drivers will also be important in identifying potential changes in driving behavior.

Figure 6: Mobileye Camera Alerts

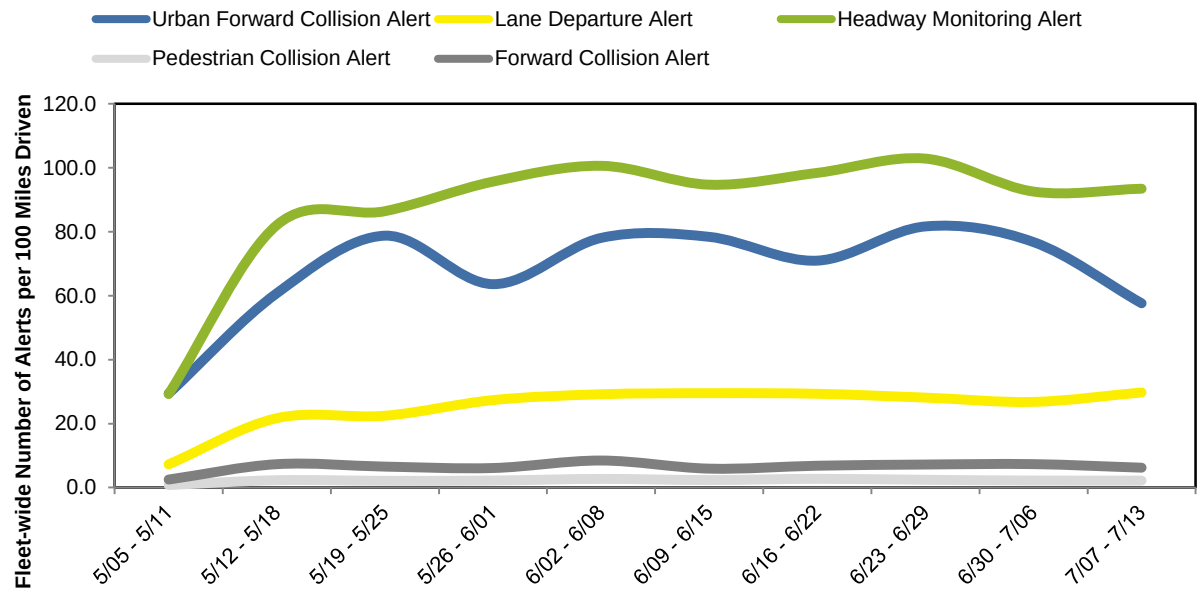


Table 3: Summary of Mobileye Alerts

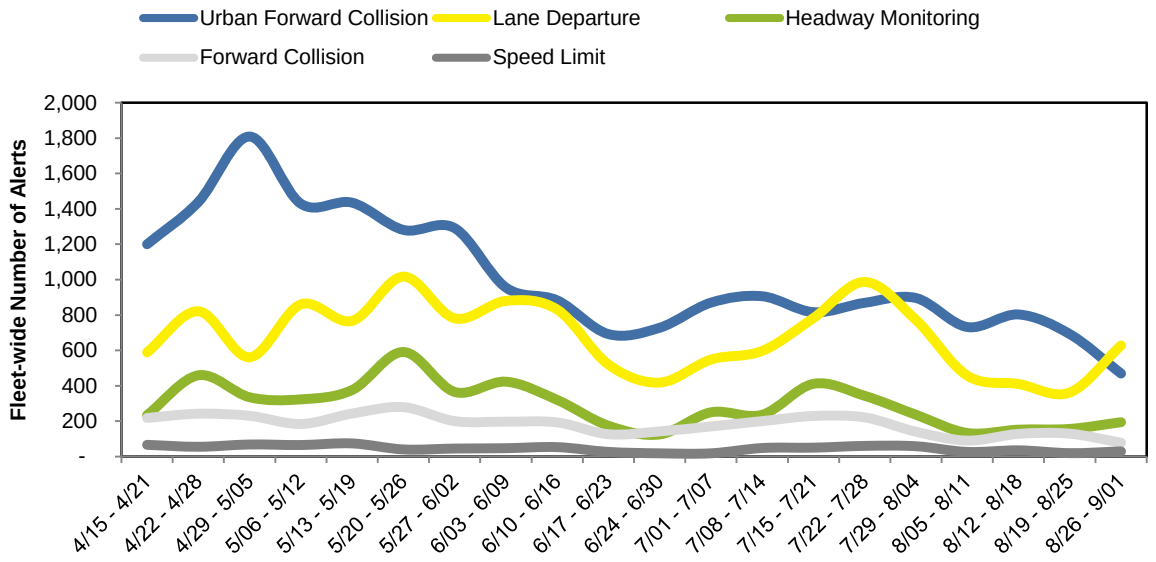
Alert Name	Alert Description
Urban Forward Collision Warning	At low speeds, Mobileye's software creates a "virtual bumper" which adds a "buffer zone" on top of the known physical bumper location. The goal of this warning is to reduce the number of non-fatal "fender bender" accidents. [3]
Lane Departure Warning	A warning that estimates if a vehicle is about to cross the lane border within the next few tenths of a second. The warning is triggered if that is the case, and the driver did not signal his intent to switch lanes.[4]
Headway Monitoring Warning	A warning that calculates the time it will take to reach the position of a vehicle driving ahead. Based off of this information and a preset threshold, the warning is triggered if a driver approaches a vehicle too closely from behind.
Pedestrian Collision Warning	A warning that informs the driver about potential collision with vulnerable road users. This system only works during the day and detects pedestrians and cyclists.

Analysis of IonFleets Alerts

The IonFleets solution incorporates the Mobileye device and, as such, produces the same types of warnings. The Mobileye devices in IonFleets' vehicles, however, do not generate pedestrian collision warnings.

IonFleets sent TLC crash data starting in mid-April. Currently mileage data is not available for these vehicles, which does not allow us to normalize alerts by miles driven. However, taken as an absolute number, total alerts have dropped over time. Due to the lack of mileage data, it is not clear at this time whether the drop off in alerts is due to reduced driving activity overall.

Figure 7: IonFleets Alerts



[3] http://mobileye.com/technology/applications/vehicle-detection/urban-forward-collision-warning/
[4] http://mobileye.com/technology/applications/lane-detection/lane-departure-warning/

Driver Monitoring

The second method the Participants use to affect driver behavior is through active driver management. This can take the form of imposing an after-the-fact negative repercussion on drivers who made a poor decision while driving, or through providing education for drivers who have demonstrated poor driving habits overall. These management techniques, often undertaken by the fleet manager with guidance from the VST company, reinforce the importance of the alerts drivers receive in the vehicle and demonstrate to the drivers that someone is paying attention to the way they drive.

The VST systems in the Pilot include analytics software that fleet managers can use to review their drivers' behavior. These systems can be customized to produce reports that the fleet managers believe will help them effectively address their concerns about the operation of their fleet. As the Pilot progresses, TLC will continue to watch how fleet managers establish their reporting methodology and how they use that information to communicate with their drivers.

Additionally, each Participant allows fleet managers to change the preset thresholds used for triggering different alerts. For instance, a fleet manager concerned about tailgating can increase the headway its drivers need to maintain before the Mobileye device triggers an alarm. As fleet managers change these thresholds to respond to their drivers' habits, TLC may be able to use different thresholds as independent variables in analyzing the VST systems' effects on driver behavior.

Geographic Analysis of Alerts

Due to the small sample size and brief window for which more than one Participant provided geographic data, TLC is unable to draw preliminary conclusions from spatial analysis at this time. However, TLC staff is working with DataTrack247 to collect the same type of data and will continue to collect it from IonFleets and Mobileye for analysis and comparison.

TLC staff created the maps on the following page from breadcrumb and geo-tagged alerts data from Mobileye and IonFleets from August 11th to August 18th. Since it is likely that drivers will receive more alerts in areas where they operate more frequently, TLC normalized the number of alerts drivers received by the amount of time they were active in a particular area. In the two sets of maps below, the left-hand maps display all of the alerts participating drivers received. The right-hand maps display normalized representations of those alerts. White space in the right-hand maps represents areas where a participating vehicle drove without receiving an alert.

Most of the vehicles partnering with Mobileye are yellow taxis. As such, alerts generated by Mobileye's system tend to appear in the same areas where taxicabs tend to operate, including the Manhattan Central Business District ("CBD") and on routes to and from the airports. As the Pilot progresses and more data is collected from the Participants, areas that have a high rate of alerts per amount of time spent operating there may be revealed. Identifying these zones could help TLC design efficient policy interactions for improving safe driving.

Figure 8: Mobileye Data Mapped

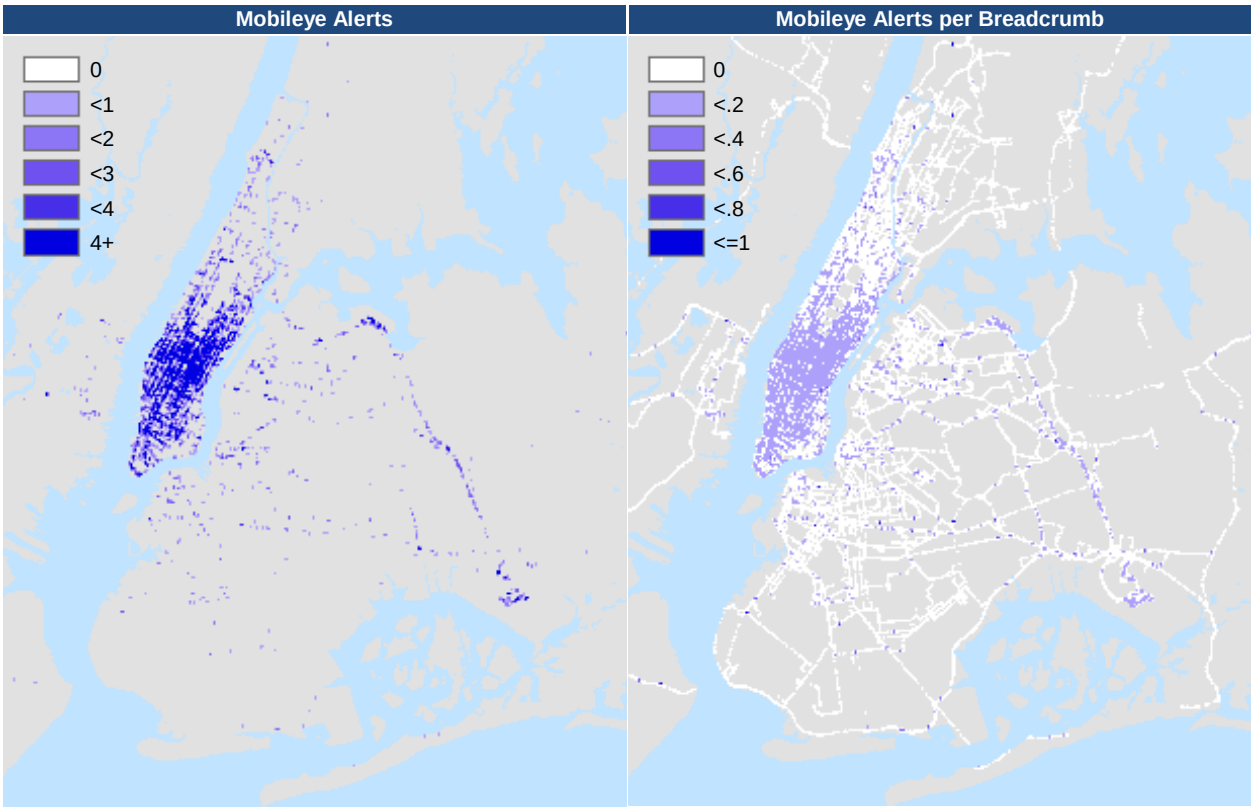
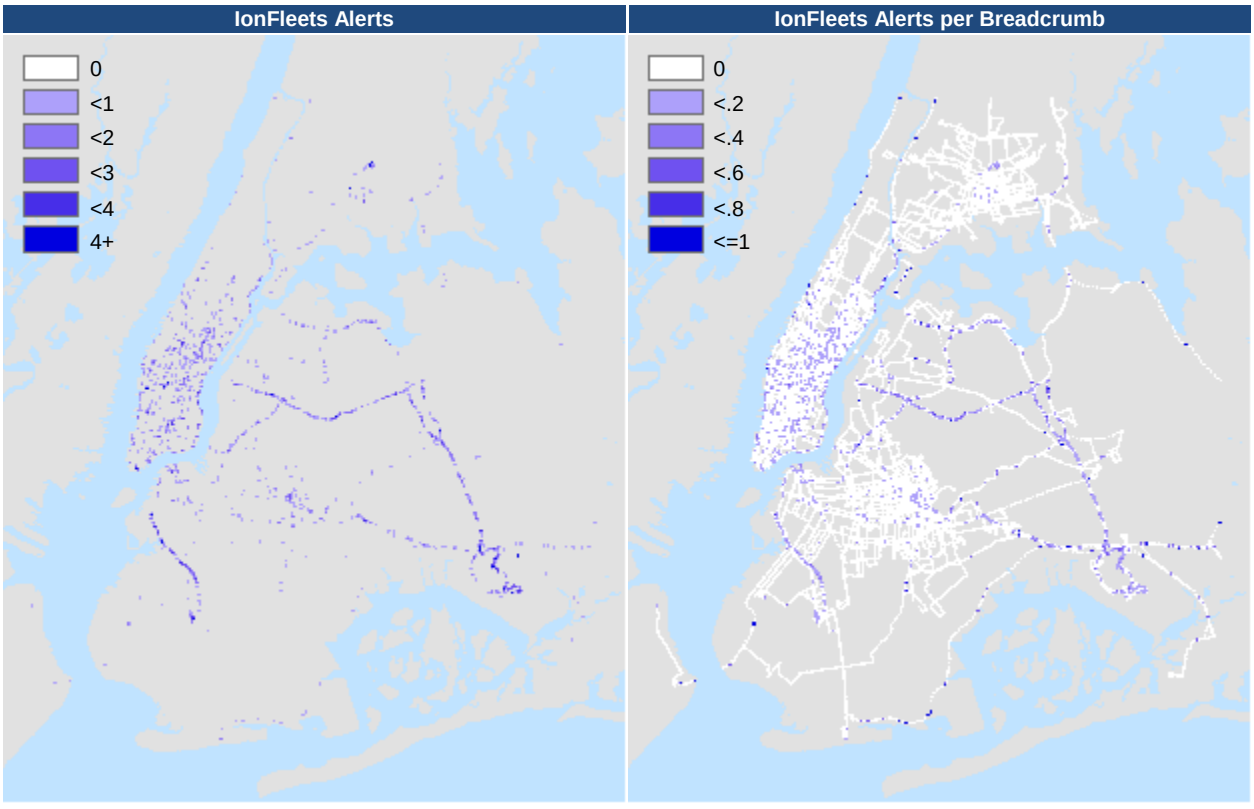


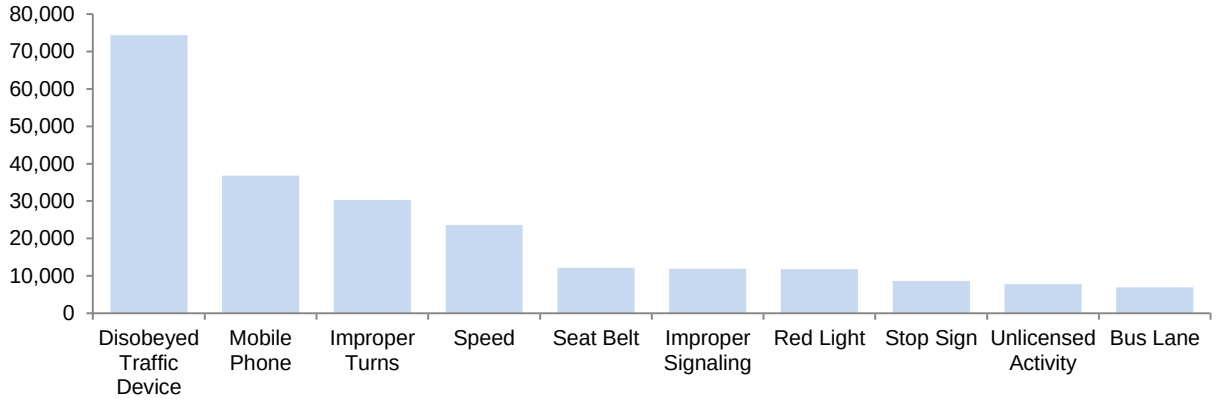
Figure 9: IonFleets Data Mapped



NYPD and TLC Summons Data

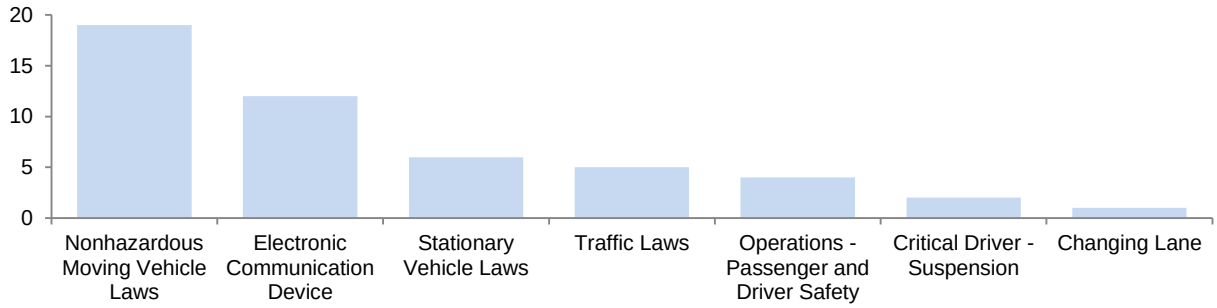
Finally, over the course of the Pilot, TLC will track the number of traffic summonses participating TLC-licensed drivers receive from the NYPD. The metrics below will serve as baselines to compare the summonses participating drivers receive over time.

Figure 10: NYPD Traffic Convictions for all TLC Licensees Since 2010



TLC will also continue to monitor whether participating drivers receive safety-related summonses from TLC's Uniformed Service Bureau. The graph below shows the total number of safety-related summonses drivers who are participating in the Pilot have received since 2010. These figures are not broken out by license type. Going forward, TLC will monitor the summons histories of the participating drivers to detect whether they stray from the average in their cohorts.

Figure 11: Safety-Related TLC Summonses Issued Only to Drivers in Pilot



Effects on Expenses

Fee Schedules

Each Pilot Participant provided TLC with a fee schedule for the hardware, software and services it would sell to owners of TLC-licensed vehicles. Those fee schedules are summarized below. However, the listed prices should be seen as typical cost ranges that the company could charge, not necessarily the prices actually charged to customers in the Pilot. For instance, IonFleets is not charging for either the upfront or operating costs for the six systems it installed. Mobileye, similarly, is not charging for the upfront and operating costs of the black boxes in the Pilot, which are not typically part of the Mobileye system. Moreover, all three Participants offer a range of products at different price points and corresponding amounts of hardware and reporting capabilities. The prices below are for the systems the Participants have chosen to be a part of the Pilot.

Table 4: Expense Comparison of Participants' Solutions

Costs	IonFleets	Mobileye	DataTrack247
Hardware	$1,790	$849	$450
Installation	*(Included in above)*	$200-250	*(Included in above)*
Monthly Operating	$59 *(data plan)* $11 *(report generation)*	$28-35 *(with typical install, $0)*	$35 *(data plan)*

Insurance

Discounts

In adopting the Pilot Resolution, TLC recognized that the use of VST systems could reduce insurance premiums, as well as the time it takes to resolve insurance claims. According to rate filings with the New York State Department of Financial Services, companies that insure TLC licensees are currently able to provide discounts to customers who employ certain in-vehicle technologies. For example, American Transit Insurance Company can provide a $300 credit to the total insurance premium for use of black boxes installed in for-hire vehicles.[5] Similarly, Maya Assurance Company can provide eligible insureds that install a video event recorder device in their for-hire vehicles a 5% credit on premiums.[6]

Usage-Based Insurance Policies

Given the limited amount of data available to date in this Pilot, and the lengthy process for approving insurance plans with the State, it is too soon to tell how the creation of usage-based insurance policies for TLC-licensed drivers would be realized. However, it was noted in discussions with insurance companies active in TLC-regulated industries that fleets that self-insure for physical damage may be able to realize a more immediate reduction in insurance costs with potentially reduced collision rates.

[5] National Association of Insurance Commissioners. "Rate/Rule" Filing. American Transit Insurance Company. "Medallion Taxi Rules And Factors" American Transit Insurance Company"
[6] National Association of Insurance Commissioners. "Rate/Rule" Filing. Maya Assurance Company Inc. "Black Car, Taxi, Luxury Car And Car Service Vehicles Rates & Rules Manual For Voluntary Program"

Passenger and Licensee Experience

As anticipated, some drivers expressed discomfort about having a device capable of monitoring their driving behavior installed in their vehicles, which was reported to us in conversation with installers and the technology companies. However, TLC has yet to see any data or receive any anecdotal evidence indicating that a fleet's use of a VST system has any effect on which garage or fleet a driver chooses to work for. TLC did, however, hear from one Participant that a driver successfully lobbied a fleet manager to turn off alerts in his vehicle. The alerts have since been reinstated, but the anecdote seems to demonstrate the driver's annoyance with having extra noise in the vehicle. TLC will continue driver, fleet, and passenger outreach throughout the Pilot to assess their experiences with this technology.

Challenges and Next Steps

Regulatory Uncertainty

Participants have expressed that some potential customers have been hesitant to purchase a VST system now in anticipation of any rulemaking the Commission makes around the technology. Potential participating fleets do not want to commit to purchasing a VST system that may not be approved under new rules.

Activity Outside of the Pilot

TLC rules do not prohibit the use of VST systems in FHVs, Commuter Vans, and Paratransits. As such, many fleets already use VST systems outside of the Pilot. In addition to the three approved Pilot Participants, several other companies began the application process but stopped in order to pursue other opportunities in the market outside of the Pilot. TLC does not know the exact number of licensed vehicles with VST systems installed outside of the Pilot, but based on information provided from the Participants, staff believes the number is well into the thousands.

Driver Specific Data

Only one company currently has the ability to systematically determine what driver is behind the wheel at any given moment. The other two require back-end data processing to match specific drivers to specific trip data. TLC received proposals from the two companies to determine current drivers in response to questioning from TLC staff, but specifics on those plans are forthcoming.

Summary and Next Steps

Though the Pilot is in its early stages, some initial data may indicate that driver alerts are affecting TLC licensees driving behavior. TLC staff will continue to collect data from companies already approved for participation in the Pilot, as well as seek additional Participants. TLC will use the data it collects to build upon the analysis in this report, and refine the data it has already received. For instance, TLC staff will work to identify which drivers were operating participating vehicles at the time of an alert in order to match alert data with specific drivers. This will allow TLC to track driving behavior trends by driver, as opposed to by vehicle. Finally, TLC will collect more information from Participants, drivers, vehicle owners and fleet managers about their experience using the VST systems in the Pilot.