Executive Summary

In February 2014, New York City released the Vision Zero Action Plan with the goal to end all traffic-related deaths by 2024. As the regulator of over 120,000 vehicles licensed for hire and the more than 180,000 drivers who drive them, TLC has a central role in Vision Zero through adopting policies and testing technologies which target unsafe driver behaviors.

Among TLC-licensed drivers, the top contributing factors for traffic collisions include driver inattentiveness, failure to yield to pedestrians, and following too closely[1]. Today, advanced collision warning and prevention systems are gradually being introduced for some vehicle models. These systems include features such as automatic braking, blind spot monitoring and lane departure warnings. While these features are not yet standard for all vehicle models[2], aftermarket solutions are also available that provide similar tools for drivers.

In 2015, the TLC commenced the Vehicle Safety Technology ("VST") Pilot (the "Pilot") to evaluate the efficacy of built-in and aftermarket technology such as electronic data recorders ("black boxes"), anti-speeding technologies, driver alert systems and related analytic software in vehicles operating within the for-hire industry. The first partipant entered in April 2015, with eight total participants joining eventually.

Through the Pilot, TLC hoped to evaluate the potential impact of the technology on crash rates. In the Pilot, most participants tested either driver alert systems or black box recording systems. Vehicles with driver alert systems exhibited an overall decrease in lane departure, tailgating, and forward collision warnings over time, while warnings for harsh braking or acceleration showed little change over time. The crash rates per participating vehicle did not show a clear decline over the course of the program. However, most data provided by participants in the Pilot were collected without identifying driver information, making it difficult to determine whether specific drivers were consistently exposed to VST in a way that could meaningfully impact crash rates. In addition, the status of many drivers as independent contractors may also impact the efficacy of VST, as many of these systems contemplate more active fleet management.

Despite the data limitations that contributed to a lack of strong evidence of a substantial impact on driver behavior, trends in general adoption and insurance company acceptance of these systems are promising. By the end of the Pilot over 2,000 vehicles were officially involved, and thousands of additional vehicles currently operate with this technology as of right outside of the Pilot. Additionally, official filings for most insurance companies providing commercial insurance to for-hire vehicles in New York City reflect a five-

[1] *Source: NYPD MV-104 report data.* Contributing factors are for all collisions involving a TLC-licensed driver. Overall, 81 percent of collisions involve just property damage, while 9 percent involve a fatality or injury of any severity.

[2] The 2018 standard model of the Toyota Camry, the most popular among TLC-licensed drivers, includes a safety package with forward collision warnings and auto-braking.

percent discount on premiums when owners incorpate certain types of VST.

At this time, TLC will not pursue rulemaking to mandate use of these systems in licensed vehicles. TLC will continue to monitor trends and studies of VST to determine if rulemaking is warranted in the future.

Background

In this report, "Participants" refers to companies who provide Vehicle Safety Technologies under the Pilot. The TLC licensees with whom the Participants worked during the Pilot are referred to as "TLC Partners."

The VST Pilot began on April 7, 2015 and concluded in April 7, 2017 after a two-year testing period. During the course of the Pilot, eight technology solutions were approved and over 2,000 TLC licensed vehicles participated. These participants provided TLC licensees with technologies that included rear- and front-facing cameras, black boxes, driver alerting/collision avoidance systems, and analytics platforms. These approved systems focused on preventing crashes by minimizing driver distraction, monitoring driving events and warning of potentially hazardous behavior.

Driver inattentiveness ranks highest in factors contributing to crashes for both private drivers and TLC licensees, according to crash data collected by NYPD. For TLC-licensed drivers, failing to yield to pedestrians and following too closely are also top contributing factors. Through the various types of technology mentioned above, Participants measured behavioral metrics that are key contributors in crashes and generated reports highlighting these driving behaviors.

Description of Pilot Participants

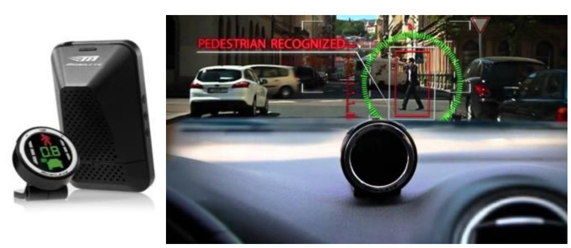
The following companies were approved to provide technologies that address risky behavior and encourage safe driving habits:

Mobileye *(approved June 2015)*

Mobileye sells driver alert systems directly to vehicle manufacturers and as an aftermarket solution for fleets and vehicle owners. In the Pilot, Mobileye provided its aftermarket solution to a fleet of primarily yellow taxis. Their technology consisted 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 provides an auditory and visual alert through the device mounted on the dash, and it vibrates the driver's seat. For the Pilot, Mobileye added a black box recorder to its system to generate data and reports for TLC's analysis.

Participant	Technology	Total Vehicles
Mobileye	Black Box, Alerts	20

Figure 1: **Mobileye** Technology System



Kaptyn (formerly IonFleets—*approved Apr 2014)*

Kaptyn bundles and provides services offered by several other companies for its customers to use in a single package. For the VST Pilot, Kaptyn provided its TLC Partners with a technology system that included three cameras (one driver-facing, one forward-facing and one rear-facing), Mobileye's alerting system (as described above), and a black box. Information from these components was aggregated in a software platform, allowing fleet managers to review footage of drivers operating the vehicle, or to see reports on the drivers' driving habits. During the Pilot, Kaptyn's driver-facing camera was approved to be used as an In-Vehicle Camera System (IVCS)[3].

Participant	Technology	Total Vehicles
Kaptyn	Black Box, Alerts, Camera	138

Figure 2: **Kapytn** Technology System

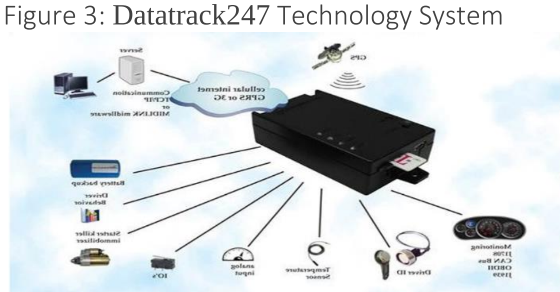
Datatrack247 *(approved July 2015)*

Datatrack247 is another service bundler. For the VST Pilot, the company provided its TLC Partners with a black box that tracks g-force events, sudden changes in acceleration such as hard braking, hard accelerating, hard turning and abrupt lane changes.

Historic and real-time information about participating vehicles is stored in a software platform accessible to its customers. The software can also be used to dispatch trips, and is used in some cases to generate trip records that are submitted to TLC as part of a reporting requirement for all TLC-licensed bases.

Participant	Technology	Total Vehicles
DataTrack247	Black Box, Alerts	2,500

Figure 3: Datatrack247 Technology System



VerifEye *(approved October 2015)*

For the VST Pilot, VerifEye installed its VOC-1 camera in for-hire vehicles and yellow taxis. Their device houses forward- and interior-facing cameras, as well as g-force sensors that monitor driver behavior. When the system identifies a g-force event, it provides the driver with an audible alert and uploads a video clip to the cloud. The company's online portal provides fleet managers or vehicle owners with access to these video clips, along with telematics information collected

[3] An IVCS is required to be installed in any Livery vehicle or yellow taxi that does not have a partition. The purpose of the system is to protect the driver against robbery or assault.

from the black box. VerifEye also provides a driver score for each driver who uses the system, based on data collected from the VOC-1.

Participant	Technology	Total Vehicles
VerifEye	Black Box, Alerts, Camera	6

Figure 4: **VerifEye** Technology System

Micronet *(approved November 2015)*

Micronet provided a safety system that included four external cameras—one forward-, one rear- and two side-facing—connected to a screen and data terminal inside the vehicle, which displays views of the driver's blind spots. The data terminal also streams telematics data to the cloud. Through continuous monitoring and analysis of the data, Micronet assigns drivers a score, taking into account aggressive and distracted driving detected by the system. Micronet's system also included a portal for fleet managers to access driver performance reporting, giving them a tool to identify and coach riskier drivers.

Participant	Technology	Total Vehicles
Micronet	In-vehicle tablet, Black Box, Camera	3

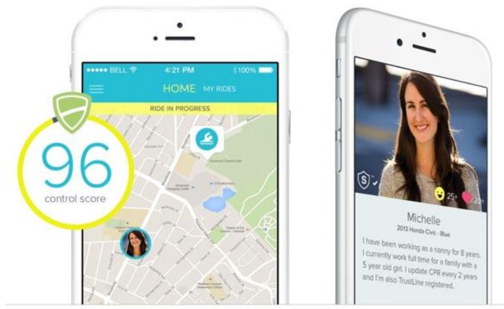
Figure 5: **Micronet** Technology System

Zendrive *(approved January 2015)*

Zendrive is an app that uses a smartphone's GPS, accelerometer, and gyroscope to measure behaviors that are typically collected by telematics devices, such as hard braking, hard acceleration, hard turning, and speeding. This system also monitors a driver's interaction with the smartphone while operating the vehicle as a a way to measure distracted driving. Zendrive can be downloaded as a standalone app, and other apps can also include Zendrive's technology in the background by integrating their Software Development Kit. Zendrive also provides driver safety scoring through its portal based on the data it collects.

Participant	Technology	Total Vehicles
Zendrive	Smartphone Telematics	20

Figure 6: **Zendrive** Technology System



Brain Tree *(approved April 2016)*

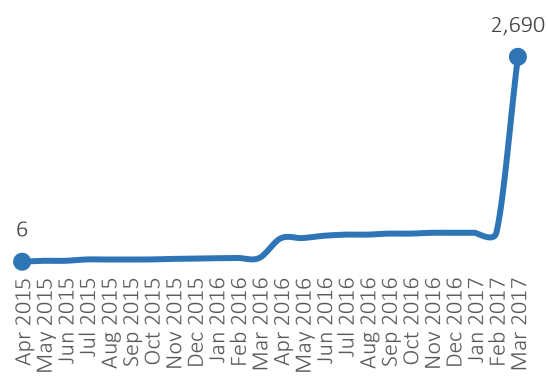
Brain Tree is a service bundler that provided a black box solution to TLC Partners. In addition to collection of typical telematics information about driver behavior, the company's system also tapped into a vehicle's on-board computer to provide a fleet manager or vehicle owner with diagnostic information remotely. The black box also provided driver alerts in real time.

Participant	Technology	Total Vehicles
Brain Tree	Black Box, Alerts	3

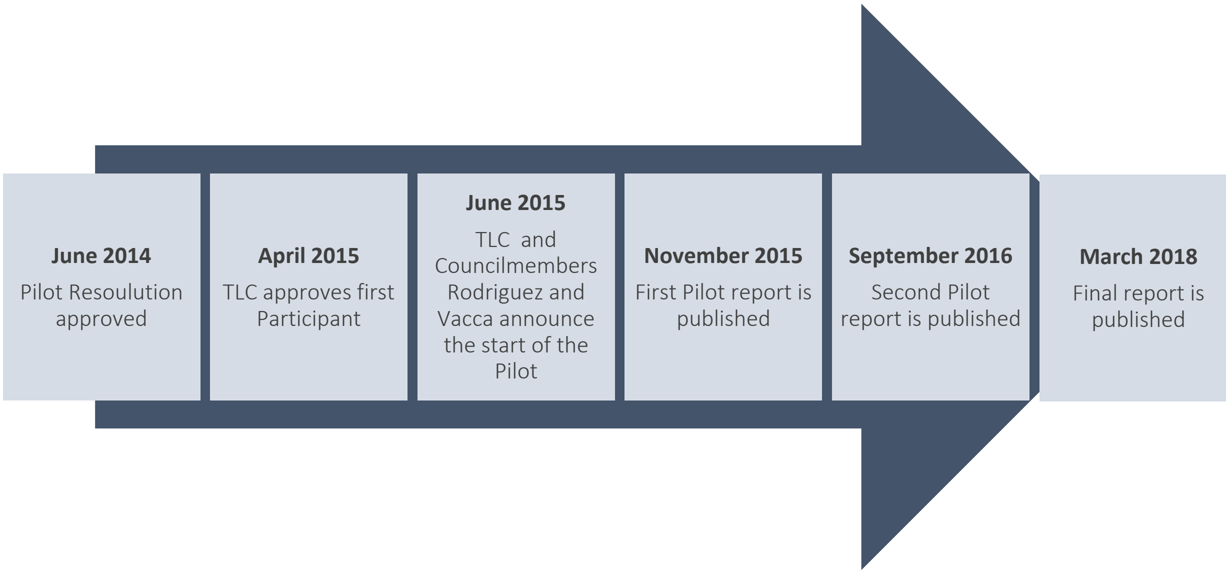
Figure 7: **Brain Tree** Technology System

The majority of Pilot Participants installed their devices within vehicles operating in the FHV sector. During the early stages of the Pilot, Participants expressed concerns from TLC Partners regarding lengthy installation periods and being monitored while working. Taking these concerns into consideration, Participants adjusted installation procedures and ensured TLC Partners were familiar with system functionality. Participants stated that over time the licensees had increased familiarity with the respective systems and associated benefits, and the number of vehicles incorporating VST grew substantially. Figure 8 shows the increase in TLC Partners working with Participants during the Pilot.

Figure 8: TLC Partner Vehicles



Pilot Timeline



Effect of VST on Crash Rates

TLC analyzed crash data provided by the New York Police Department (NYPD) to determine the crash outcomes for Pilot vehicles between April 2015 and June 2017. As a point of reference, TLC-licensed vehicles were involved[4] in less than 20 percent of all reported crashes in New York City. Black cars and yellow taxis were involved in more crashes compared to other license types; however, when taking into account the crash rate per vehicle, the crash rate for Black Cars is comparable to other FHVs. The crash rate for yellow taxis is still higher on a per-vehicle rate, but these vehicles typically spend more time on the road compared to other vehicle classes. In 2016, the average yellow taxi logged 57,000 miles on the road, compared to FHVs, which logged only 35,000 miles on the road, on average[5].

Over the course of the Pilot, the number of crashes involving participating vehicles did not show a sustained downward trend, including when accounting for the number of trips performed or the number of active vehicles (according to an analysis of TLC trip records). Figure 9 shows the crash rate per vehicle for TLC Partner vehicles in the Pilot alongside crash rates for all other TLC-licensed vehicles. As more vehicles joined the Pilot (over 300 vehicles by Q2 2016), the crash rate oscillated between 0.10 and 0.15 crashes per vehicle in each quarter.

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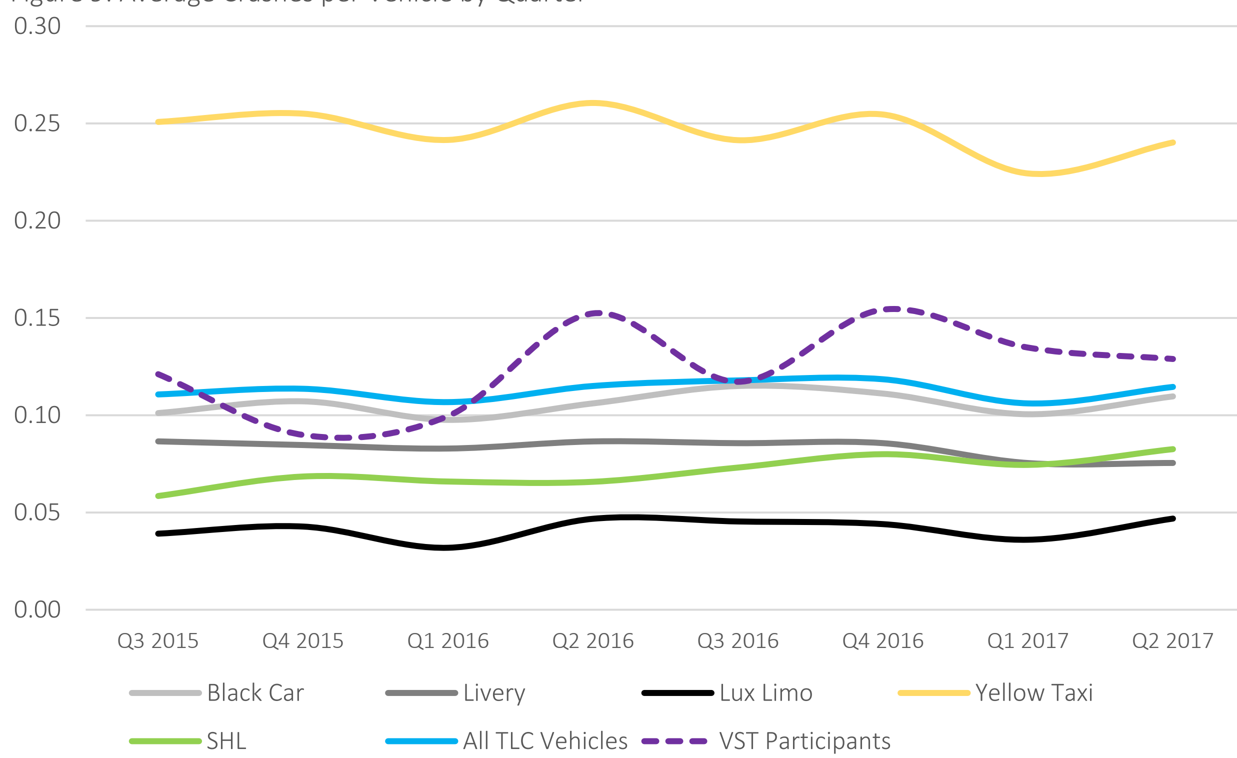
4 Crash records indicate whether a TLC-licensed vehicle was involved, not whether the driver or vehicle is at fault. Crashes include those involving property damage, which comprise the vast majority, in addition to those involving an injury or fatality.

5 This average is determined from measuring mileage between consecutive vehicle inspections at TLC's Safety and Emissions facility.

The fact that crash rates did not decrease may not be an accurate indication of whether individual drivers are driving more safely. Vehicles may be outfitted with VST, but if multiple drivers are using the vehicles, as is common with yellow taxis, those drivers may not receive the intended benefit of the technology because they may not be getting consistent exposure to alerts, scoring, or remediation for unsafe driver behaviors. Also, individual improvements in driving may be diluted in metrics when multiple drivers share the same vehicle. The status of many drivers as independent contractors may also impact the efficacy of VST, as many of these systems provide fleet management portals and contemplate more active fleet management. If individual fleets do not use the information provided to coach drivers or incentivize changes, alerts alone may not provide the desired safety outcomes. Current insurance models, while they do give upfront discounts for the inclusion of VST, may not be encouraging more meaningful changes in driving behaviors because they do not offer discounts tied directly to demonstrated improvements in driving.

Figure 9: Average Crashes per Vehicle by Quarter



Note: not adjusted for mileage or time

Alert Rates in the Pilot

Participants' alerts fall into two categories: reactive and proactive. Reactive alerts remind the driver that a specific behavior is unsafe with the aim of preventing that behavior in the future. These alerts typically occur in real time when a behavior is detected.[6] Proactive alerts, on the other hand, warn drivers of potentially dangerous situations, such as another vehicle in a driver's blindspot. VST systems in the Pilot detected unsafe behaviors and environments through two main ways: cameras and sensors such as GPS devices and accelerometers. Table 1 shows a description of each type of sensor source for alerts.

Alerts detected by VST systems target the three top contributing factors for crashes involving TLC-licensed vehicles: driver inattentiveness, failure to yield to pedestrians, and following too closely. A select group of alerts from each Participant is listed in Table 2, showing the type of alert and the contributing factor that it targets.

Table 1: Main Sources of Alerts

	Mobileye Sensors	Black Boxes/Smartphones
Sensor	Forward-facing camera	Accelerometer, GPS
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 anticipate potential collisions	Monitors g-forces imposed on vehicle, registering when they exceed a preprogrammed threshold. Measures distance using GPS and time to calculate speeding events.
Used by	Kaptyn, Mobileye	All Participants

[6] One of the Partipants , Zendrive provides the driver with feedback after each trip.

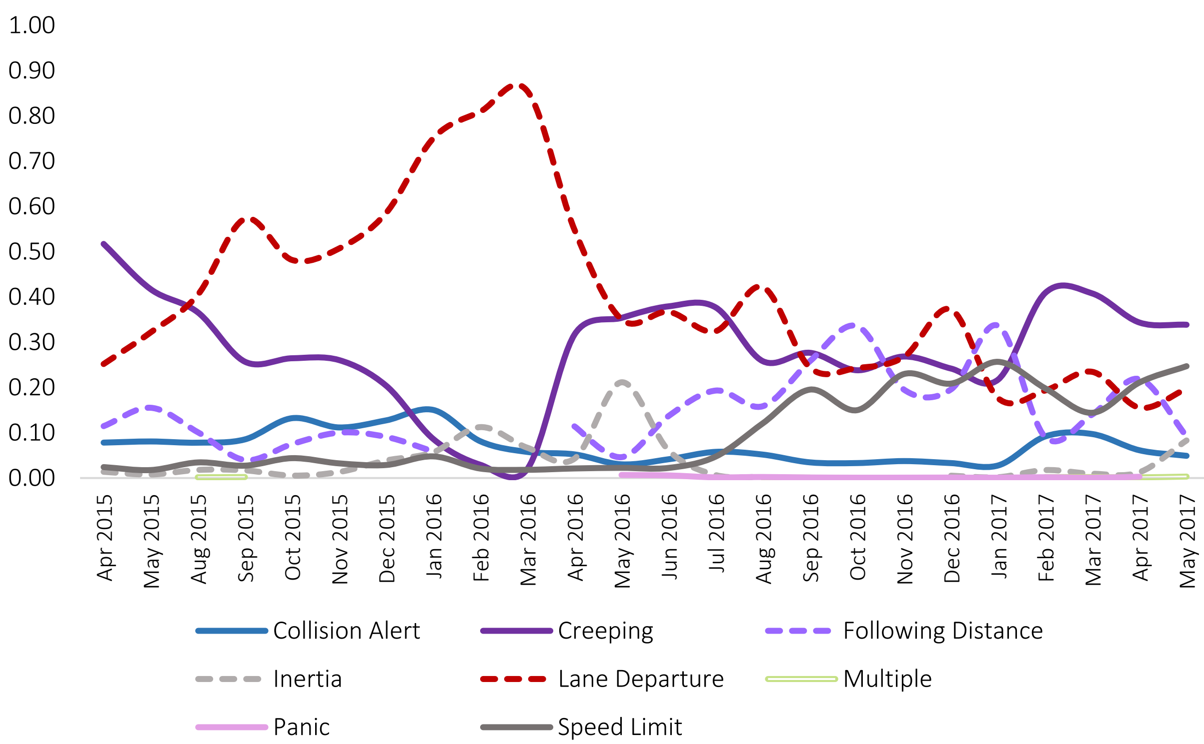
Table 2: Alerts by Participant

	Alert Type		
	G-force changes	Object detection	Device usage
Contributing Factor Targeted			
Driver Inattentiveness	x		X
Failure to Yield to Pedestrians		x	
Following Too Closely	x	x	
Participant Alerts			
Kaptyn	Inertia	Collision Alert Lane Departure Creeping Following Distance	
Mobileye		Pedestrian Collision Warning Forward Collision Warning Lane Departure Warning Headway Warning	
DataTrack247	Hard Braking Hard Acceleration Hard Right Hard Left		
ZenDrive	Harsh Braking Harsh Acceleration		Phone Usage

Below, we have provided a summary of our analysis of each Participant's alert data. Overall, the results are mixed. For TLC Partners using some VST solutions, alerts have declined over time. For others, TLC has observed an increase over the course of the Pilot. Ultimately, the goal of incorporating these systems into TLC-licensed vehicles is to discourage drivers from performing the detected behaviors (speeding, hard braking, hard acceleration, etc.). When drivers are not consistently exposed to these systems day in and day out, or when coaching or remediation does not accompany the alerts, the behavior may continue. However, drivers who operate vehicles with these systems even sporadically have an opportunity in the moment to correct the behavior, so an increase in alerts can result in positive short-term corrections for drivers. As these systems generally become more prevalent, drivers will be more consistently exposed to alerts, scoring, or training, increasing the potential for more long-term behavior changes.

Figure 10 shows alerts per active vehicle operating with Kaptyn's VST system during the Pilot. Kaptyn's system was installed primarily in yellow taxis, which mostly operate in dense urban environments in Manhattan. Alerts received through Kaptyn's system indicate that *Lane Departure*, *Creeping* (defined as one vehicle rolling toward another vehicle) and *Following*

Figure 10: **Kaptyn Daily** Alerts per Active Vehicle



Distance were the most prevalent alerts. Over time, *Lane Departure* alerts increased to a peak of nearly 0.90 alerts per vehicle in March 2017 before declining to 0.20 alerts per vehicle in May 2017. *Creeping* and *Following Distance* alerts showed no clear trends, decreasing and then increasing over the course of the Pilot. *Speed Limit* alerts per vehicle remained low in the beginning of the Pilot but increased to 0.20 alerts per vehicle in September 2016, staying at that level through the end of the Pilot.

Figure 11 shows alerts per 100 miles for vehicles operating with Mobileye's VST system during the Pilot. Alert rates for most events declined early in the Pilot and then remained flat, including *Pedestrian Collision Warning*, *Forward Collision Warning*, *Lane Departure Warning Headway Warning*, and *Urban Forward Collision Warning* alerts. *Headway Warning rates*—alerts for tailgating—decreased the most over the course of the Pilot, from 100 alerts for each 100 miles traveled (or one alert per mile) in July 2015 to between 20 and 40 alerts per 100 miles starting in January 2016.

Figure 11: **Mobileye** Alerts per 100 Miles

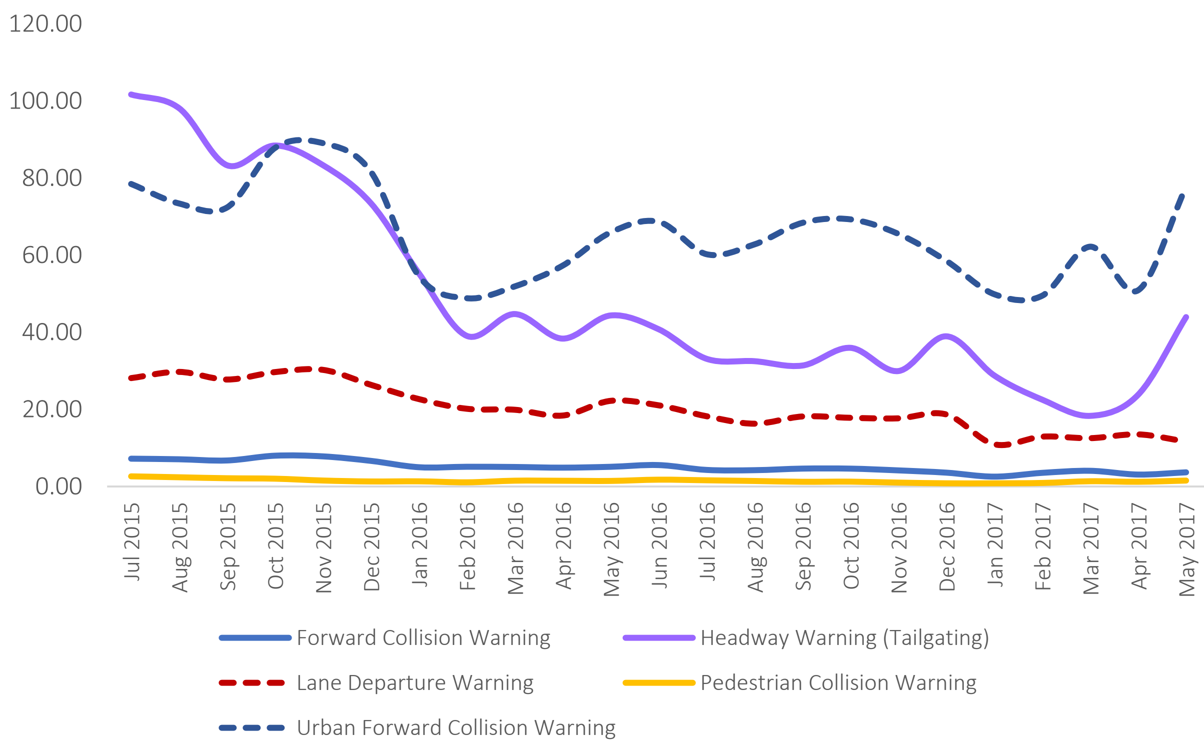


Figure 12: **DataTrack247** Alerts per 100 Miles

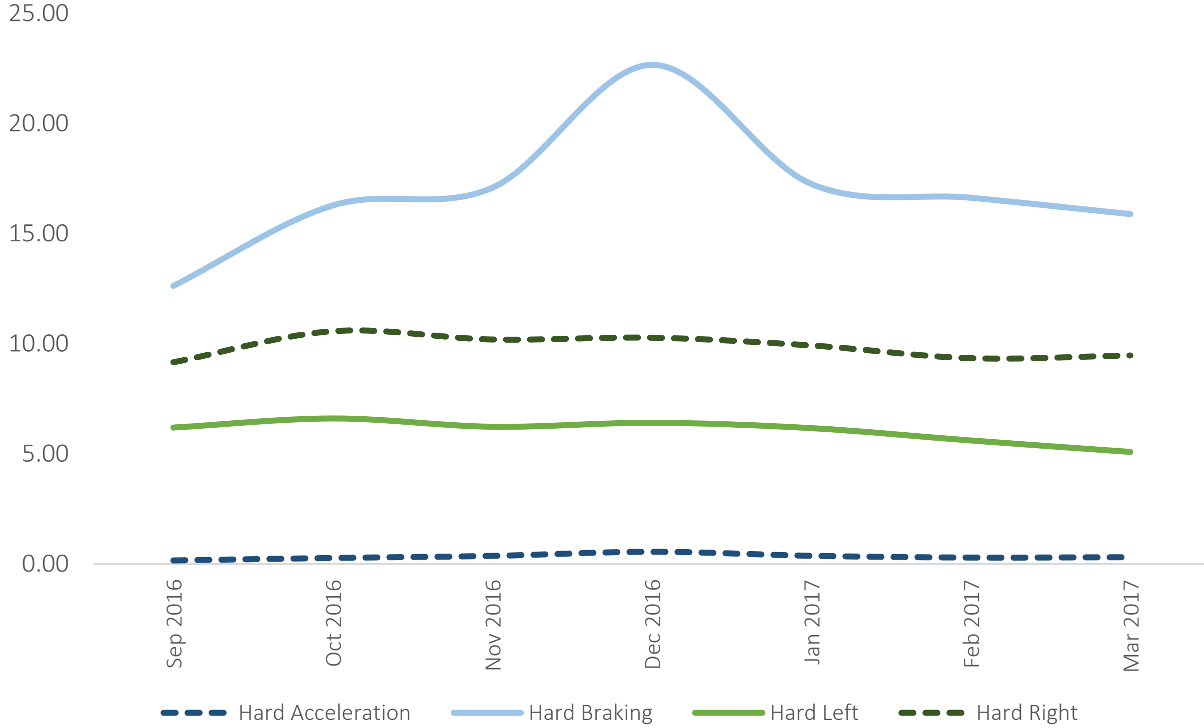


Figure 13: **Zendrive** Alerts per 100 Miles

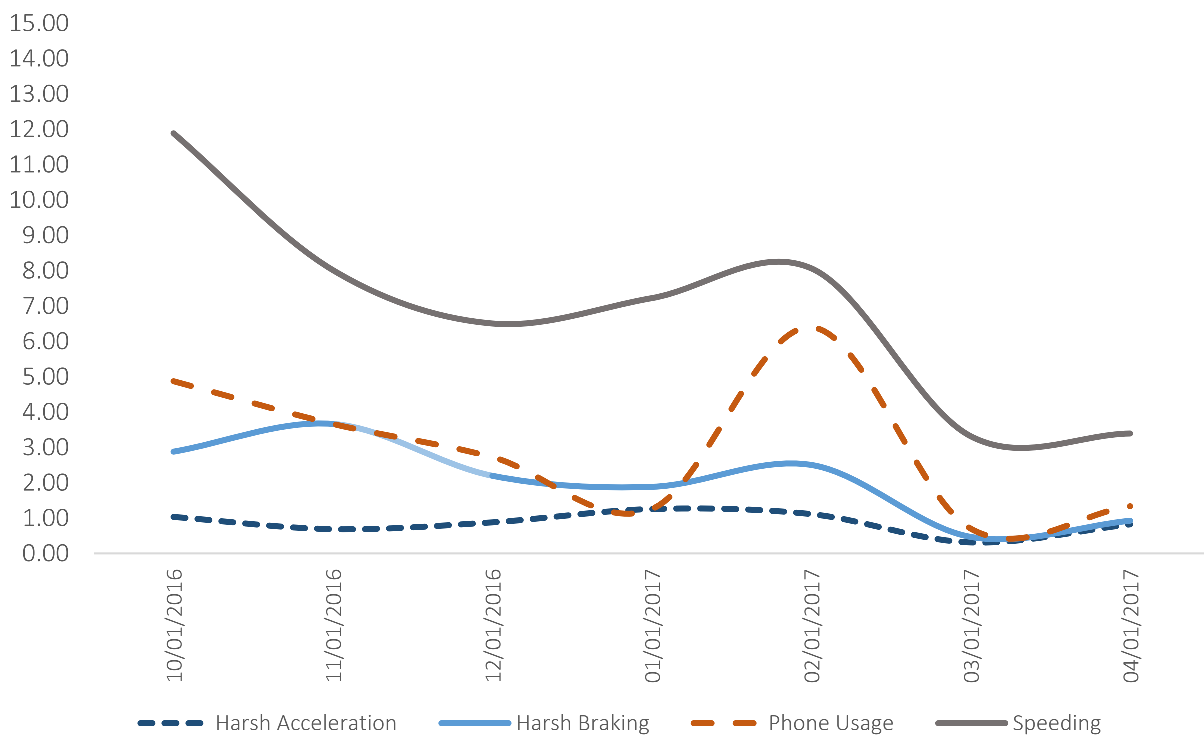


Figure 12 shows alert rates per 100 miles driven for vehicles equipped with DataTrack247's system in the Pilot. Overall, alert rates remained steady for the reported months. Alerts for *Hard Acceleration* and *Hard Left* and *Right* turns remained below 15 alerts for every 100 miles driven in the Pilot. The rate for one type of alert, *Hard Braking*, increased to a peak of nearly 23 alerts per 100 miles in December 2016, falling after and hovering between 15 and 17 alerts per 100 miles for the remainder of the Pilot.

Figure 13 shows alerts per 100 miles traveled with Zendrive's VST system during the Pilot.[7] Overall, the rate of Zendrive-detected events decreased over time. *Speeding* events declined from 12 events per 100 miles in October 2016 to less than 4 events per 100 miles in April 2017. Phone usage per 100 miles declined in the first few months Zendrive's solution was installed in TLC Partner vehicles, but increased sharply to over 6 events per 100 miles in February 2017. Following this increase, *Phone Usage* events per 100 miles declined again, reaching 1.3 alerts per 100 miles by the end of the Pilot. The increase for both *Speeding* and *Phone Usage* events in February 2017 is likely due to a smaller number of active TLC Partner vehicles during that time, which may have magnified the impact of an alert.

Alerts for ***VerifEye, Micronet,*** *and* ***Brain Tree***

For each of these participants, data were either sparse because of a small number of TLC Partner vehicles[8] or because VST systems were installed for a limited period of time, so alert rates for these Participants are not presented here.

Impacts on Expenses

Most VST relies on additional in-vehicle technology. Because Zendrive has its TLC Partners use their own smartphone, the marginal cost of using its service is a $0 upfront cost, and a $2 monthly fee charged for the analytics the company provides. (Assuming purchase price and the service plan for the smartphone is excluded from the cost).

Vehicle insurance is one of the largest expenses owners—and many drivers, since they are often also vehicle owners—face. From conversations with insurance companies, TLC understands that VST solutions, especially those which include cameras which capture video around an incident, can be extremely useful for settling insurance claims quickly. Some insurance companies active in TLC-regulated markets offer policy discounts to vehicle owners who install black box and camera systems in their vehicles, currently at a rate of five percent. The premium discount is likely currently based on claim-resolution efficiencies gained with additional event data collected and not on actual driver behavior. TLC is not aware of any of those insurers basing policies on telematics data, but we understand that some VST participants are attempting to demonstrate their systems' capabilities to insurers in an effort to achieve additional insurance savings. Recently, some insurance companies have indicated that

[7] Zendrive did not provide event-level data, but instead provided TLC with reports showing the calculated alert rates per mile.

[8] Brain Tree and Micronet each had three participating vehicles; VerifEye had six.

upfront discounts may be increased to ten percent.

Table 3: Costs per Participant

Participant	Initial Cost	Monthly Costs
Kaptyn	$1,790	$70
Mobileye	$1,050 - $1,100	$28 - $35 (with black box)
DataTrack247	$450	$35
VerifEye	$785	$18
Micronet	$1,600 - $2,400	$35 - $75
Zendrive	$0	$2
Brain Tree	$799	$35*

*Estimate based on $420 annual cost.

TLC is aware that the New York State Department of Financial Services, the state agency in charge of approving new types of insurance, has expressed interest in approving insurance products that use telematics data in underwriting and for adjusting rates. Usage-based insurance in the for-hire industry could provide a clear incentive for safe driving that does not exist today. Upfront discounts are helpful for the adoption of the technology, but rates that vary based on *actual* driving behaviors would be a more effective feedback loop for drivers using VST.

Conclusion

The development of sensors, cameras, digital applications and a variety of other in-vehicle technologies targeting risky driving behavior may help drivers correct that behavior before danger is imminent. The results of the Pilot were encouraging but not conclusive, partly because Participant data were specific to vehicles and not drivers. Currently VST technology is best-suited as a fleet management tool. Because many of our licensed drivers are independent contractors, and because one vehicle may have several drivers, it is difficult to draw conclusions about the impact of VST on specific drivers' behavior.

Although TLC is not recommending rulemaking at time this time, we are encouraged by the range of functionality displayed in the pilot.

The Pilot has demonstrated a strong interest from the industry to adopt technology that aids in safe driving. Thousands of vehicles officially participated in the Pilot, and insurance companies are now contemplating ways to expand on incentives they already provide for licensees who incorporate VST. TLC is interesed in the evolution of these incentives, especially around usage-based insurance. Because fleet owners only exert a certain level of intervention with drivers due to their independent contractor status, insurance and technology solutions should focus on ways to create meaningful feedback loops for drivers to create long-term behavioral change. As always, TLC welcomes any feedback or data from technology companies, fleet owners, vehicle owners, or drivers in the future.