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Video Cameras in Access Link Paratransit Vehicles

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Every effort was made to uniformly contact each technology manufacturer/vendor. Cost information was provided by vendors or acquired from existing vendor contracts. Results and recommendations presented herein provide a side-by-side comparison of technology which may or may not account for all cost variables or benefits.

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Abstract

New Jersey Transit (NJ TRANSIT), under purview of the Americans with Disabilities Act (ADA) paratransit requirement, operates a fleet of 360 Access Link vehicles. The current Access Link paratransit fleet uses a short-segment video monitoring system. This system captures 20-second video clips generated upon G-force or manual triggers. Since implementation in the Access Link fleet, there have been significant changes to the technologies available and to contract cost structures of vendors. In addition, newer technologies on the market—especially continuous video monitoring systems—provide a greater amount of information and features than the currently installed systems.

The research team conducted a national survey of transportation providers and found that 86 percent of the survey respondents use a continuous video monitoring system. Nearly all operators with a continuous video monitoring system reported satisfaction with their respective system, regardless of vendor. Continuous video monitoring system users cited many occurrences of their system capturing events and sequences that would not be triggered with a short segment system, including actions that lead up to an event. This additional footage greatly aided event investigation, incident resolution, and employee training efforts.

Many benefits are difficult to quantify in dollars saved due to their relationship to employee safety, oversight, customer relations, etc. Therefore the benefits quantified focused on the reduction in liability and insurance claims. Overall, a continuous recording system provides additional features and captures significantly more events. This creates a potential for additional savings, which may be greater than increased costs of the more expensive system. Based on the results of the research, NJ TRANSIT could expect that: 1) without a system they would incur a liability/claim cost of $706,644 per year, 2) current segmented recording installation they incur a liability/claim cost of $293,519 per year, and 3) replacing their segmented system with a continuous recording installation "could" further reduce their liability/claim cost to $145,335 per year. This data is speculative and is statistically sensitive to claim trends and extreme claims resulting in large one-time payouts that vary significantly from the average claim cost. However there are many additional tangible benefits associated with the additional information collected by a continuous system.

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EXECUTIVE SUMMARY

A research study was conducted by Rutgers, the State University of New Jersey, on behalf of NJ TRANSIT and NJDOT to investigate alternative technologies for video monitoring systems in paratransit vehicle fleets. The Access Link paratransit fleet currently uses a DriveCam monitoring system. This system captures 20-second video clips generated upon G-force or manual triggers. Since implementation in the Access Link fleet, there have been significant changes to the technologies and contract cost structures available on the market. In recent years, DriveCam has changed their contracting practices; exclusively offering monitoring contracts. In addition, newer technologies on the market—especially continuous video monitoring systems—provide a greater amount of information and features. As a result, NJ TRANSIT is revisiting its needs and vendor selection.

This report outlines the research efforts used to identify and quantify the technology, contract structure, and user satisfaction with various systems. Efforts included a national survey of transit agencies, Request for Information (RFI) of equipment vendors, and a detailed cost-benefit analysis.

The national survey of transportation providers revealed that 86 percent of survey respondents use a continuous video monitoring system. Nearly all operators with a continuous video monitoring system reported satisfaction with their respective system, regardless of vendor. A commonly reported issue of short segment system users (including NJ TRANSIT's current system) was that the system had missed capturing the entirety of one or more events. Continuous video monitoring system users cited many occurrences of their system capturing events and sequences that would not be captured by a short segment system, including pre-event actions. This additional footage greatly aided event investigation, incident resolution, and employee training efforts.

The results of the literature review and survey yielded no pre- and post- installation financial comparisons between segmented and continuous recording systems. Without the existence of historical cost-benefit data, the research team needed to extrapolate from available financial information because it could not develop a simple side-by-side benefit comparison. A "range" of potential benefits was developed to support a cost-benefit analysis. At the lower limit of the "range", since all events recorded by a segmented system would also be captured by a continuous system, it was assumed that the benefit will be at least equal to the existing segmented system. The upper limit of the "range" assumes that the continuous recording system fully reduces the liability from frivolous lawsuits to zero.

Furthermore, the research team estimated the life-cycle costs of both a continuous and segmented recording system. In order to compare the costs of the existing system with other potential systems fairly, it was important to compare systems with equivalent capabilities (i.e. same number of cameras, etc). The research team issued an RFI for a standard system, with the intent to compare similar cost data across multiple vendors. However, no segmented systems vendors responded to the RFI. In order to provide a

side-by-side comparison between the continuous and segmented technology, the team used a multiplier on the current NJ TRANSIT contracts to normalize for the additional cameras. The research team acknowledges that this potentially adds error into the cost-benefit analysis, but since no segmented vendors responded to the request, it was the only way to still perform a comparative analysis. Based on the results of the research, NJ TRANSIT could expect that: 1) without a system they would incur a liability/claim cost of $706,644 per year, 2) with their current segmented recording installation they incur a liability/claim cost of $293,519 per year, and 3) replacing their segmented system with a continuous recording installation “could” further reduce their liability/claim cost to $145,335 per year.

In addition to quantifiable liability savings of continuous recording systems used for the cost-benefit analysis, there are many qualitative benefits. Many benefits are difficult to quantify in dollars saved due to their relationship to employee safety, oversight, customer relations, etc. These benefits are realized in improved operational metrics, increased ridership, and overall customer satisfaction with the service.

Overall, a continuous recording system provides additional features and captures significantly more events than a segmented system. This creates a potential for additional savings, which may be greater than the additional costs of a more expensive system. While a continuous system will require a larger initial investment in equipment, it will afford the agency many features that are not available in a segmented system.

Segmented systems such as DriveCam, are appropriate and beneficial for some applications, however, the users must decide if the additional information collected by a continuous system is right for their agency. For example, segmented systems that primarily use G-force triggers may not be appropriate in situations that rarely have G-force events and require continuous documentation of human interaction issues outside of crashes. Regardless of whether segmented or continuous recording technology is used, there is a benefit to the agency and the customers. The research showed that there could be a significant liability savings over the life of the equipment. However, this savings could be significantly different depending on vendor or optional features that add costs but also provide a more robust system with additional benefits.

The research team findings support NJ TRANSIT upgrading the current segmented system in AccessLink to a continuous recording system. Based on the criteria required by NJ TRANSIT and the analysis presented (specifically cost data provided by the vendors who responded to the request for information), Vendor1 would likely result in a larger savings with a lower potential risk for underperforming the existing system. Due to reduced expenditures, primarily in insurance claim payouts, the cost of the Vendor1 system would likely be recouped from savings within 3 to 4 years. Likewise an investment in Vendor2 would likely be recouped in 4 to 5 years.

BACKGROUND

NJ TRANSIT, in compliance with the Americans with Disabilities Act (ADA) paratransit requirements, operates a fleet of 360 Access Link vehicles to provide mobility to individuals who are unable to use local bus service as a result of their disability. In 2006, NJ TRANSIT began to outfit their fixed route bus fleet with the DriveCam video surveillance system.(1) The DriveCam system captured 20 seconds of video per incident with the intent of increasing safety, providing surveillance, reducing driver error, and lowering NJ TRANSIT's liability exposure. Based on the results of the fixed bus route program, Access Link began using this segmented video monitoring system to enhance safety and security.

The DriveCam monitoring system captures 20 second video clips triggered manually or by a G- force sensor. Since implementation in the Access Link fleet, there have been significant changes to video monitoring technologies available. In addition, the contract structure between NJ TRANSIT and the video monitoring system provider have evolved to allow for more timely access to the data. Newer technologies on the market, especially continuous video monitoring systems, provide a greater amount of information and features than NJ TRANSIT's current system.

In September 2011, the agency announced plans to expand the DriveCam installation to its entire fixed route fleet to be completed by the end of 2014.(2) However, due to the distinct needs of the Access Link fleet operations, continuous video monitoring systems would capture events not triggered by a segmented system.

Access Link requested research into available recording systems, including those that provide real-time access to video feeds. Two critical factors were identified by NJ TRANSIT Access Link as reasons to investigate new video monitoring systems. Access Link is interested in having complete videos of incidents that would not be available through a short segmented monitoring system; such as evidence of what led up to an incident. Secondly, DriveCam no longer offers their hardware for direct sale, making it challenging to receive timely access to critical data for NJ TRANSIT event management protocols.

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[1] "NJ TRANSIT tests DriveCam bus surveillance system" Homeland Security Newswire, October 26 2006. http://www.homelandsecuritynewswire.com/nj-transit-tests-drivecam-bus-surveillance-system

[2] TCRP Synthesis 90 - D.M. Schulz and S. Gildbert. Video Surveillance Uses by Transit Rail Agencies. Transit Cooperative Research Program, 2011.

This research outlines existing recording technologies on the market and provides NJ TRANSIT with an understanding of how they may be implemented into the Access Link paratransit fleet.

OBJECTIVES

In cooperation with NJ TRANSIT and NJDOT, the research team explored the potential of on-board video camera systems on paratransit vehicles. With the advancement of technology and the change in required contract structure with Access Link's current vendor, the team conducted a study of alternative technologies appropriate for Access Link's daily operations. Access Link will be able to make an informed, data-driven decision on video monitoring systems in advance of a fleet-wide application.

At the onset of the study, NJ TRANSIT was specifically interested in the following items:

1. Identify the actual current use of continuous recording in demand response or other public transportation applications in the US.
2. Determine the projected costs per vehicle within the next three years for continuous recording versus DriveCam type.
3. Document actual use of continuous recordings in legal cases for in demand response and/or school and public transportation.
4. Determine the savings achieved from the use of continuous recording in legal challenges, both vehicular and criminal.
5. Identify any systems that have migrated from short segment recordings to continuous recording.
6. Determine if there are any transportation systems that abandoned continuous recording and have returned to short segment recording. Determine what the reasons were for the change especially in terms of costs, support, and ROI.
7. Discuss, compare, and document the transfer and storage of data, methodologies, available costs, etc.
8. Determine the capability of downloading data in a wireless fashion vs. a removal hardware medium.
9. Determine if the data falls under OPRA for public access.
10. Speculate where continuous recording technology will advance within the next three to five years.
11. Determine if costs can be controlled depending on picture quality and, if so, to what extent are they dependent on digital, analog, or other technologies now available or anticipated in the future.
12. Determine if costs can be controlled depending on audio quality and, if so, to what extent are they dependent on digital, analog, or other technologies now available or anticipated in the future.
13. Consider the types of systems available and discuss the number of cameras recommended for a Paratransit application with optimal coverage.

INTRODUCTION

The research project was broken out into five distinct tasks:

1. Literature Review
2. Analyze and Evaluate Existing Products & Limitations
3. National User Survey
4. Cost-Benefit Analysis
5. New Technologies

The Rutgers research team conducted an extensive literature review (Task 1) to identify the video monitoring system technologies available on the market. This review included the technological systems and also examined issues related to their deployment. Some identified issues included: legal concerns, workforce acceptance, documented benefits of implementing a video monitoring system, and product vendors. The results of the literature review included an extensive list of vendors and video monitoring systems.

In Task 2 (Analyze and Evaluate Existing Products & Limitations), the research team developed a uniform set of system parameters to present to Access Link. The parameters and vendors identified in Task 1 were used in Task 2 to further create a comprehensive review of existing products. Access Link reviewed these parameters and specified five that are critical to their operations. These critical parameters were: (1) continuous recording, (2) the ability to use at least five cameras per vehicle, (3) nighttime or low-light recording, (4) recording of the area outside of the vehicle, and (5) real-time monitoring. These parameters were used to define a baseline system in which cost information was solicited from vendors through a Request for Information (RFI) in Task 4.

In addition to the traditional literature review conducted in Task 1, the research team conducted a user survey of video monitoring systems. The survey provided feedback from transit and paratransit agencies. In Task 3, through a national survey, the research team identified the types of systems currently in use and the satisfaction levels of responding transit agencies. The survey results provided an understanding of technologies and vendors' strengths and weaknesses. In addition, the survey identified the state of the market and level of technologies adopted nationally.

The team conducted a cost-benefit analysis in Task 4 based on the needs identified by NJ TRANSIT in Task 2. The baseline requirements were the amount of technology to be installed (e.g. number of cameras, exterior camera), and specific features (e.g. continuous recording, real time video).

In order to present a comparison of potential costs to the identified benefits, 16 vendors identified in Task 1 received an RFI asking for a non-binding proposal to equip the Access Link fleet with the identified baseline system.

For Task 5, the research team provided an overview of new and emerging technologies for Access Link. These include enhancements to the video monitoring systems, such as

passenger counting as well as improvements for passengers, such as mobile or web based scheduling & vehicle tracking.

This research approach provided a comprehensive review of existing and future technologies as well as the state of the industry in order to ensure that any large capital investment by NJ TRANSIT in the Access Link fleet is supported by a data-driven analysis.

WORK PERFORMED

TASK 1 - LITERATURE REVIEW

The literature review revealed both technical and non-technical considerations important when implementing a next generation continuous video monitoring technology for Access Link. Technical considerations include: data integration & fusion, data transfer, event triggers, associated costs, benefits, monitoring & contract information, and durability & service life. An extensive comparison of these parameters (Table 3), in relationship with the vendors (Table 2) that provide them, are offered in the Task 2 section of this report.

The research team recognized that to properly review continuous video monitoring systems, more than just the technology needed to be considered. For example, legal and human relation issues, such as insurance claims, driver training & monitoring, and safety performance of the fleet, are positively impacted by the presence of video monitoring systems.

Video monitoring systems have become more prevalent throughout the United States as a means to ensure public safety. The literature review found that the evolution of the medium upon which video is captured has a profound impact on future continuous video monitoring systems. With more modern technology, recorded video on a transit vehicle can very clearly, accurately, and more completely articulate an understanding of an event subject to inquiry. With an increase in the video duration, recording quality, and multiple camera angles, the comprehensive video can assist in the recreation and analysis of an event. The integration of other sensor data can provide information about the vehicle and the operator's actions such as acceleration, air bag deployment, and position of the vehicle. Wireless technology advancement has also made possible the ability to transmit data in real-time over secure internet connections, lessening the need for in-vehicle storage of data.

Recognized benefits of a video monitoring system include increased safety, fleet efficiency, and reduced costs from claims, liability, and insurance. For example, the literature revealed that "driver knowledge" of the presence of a monitoring system can reduce collisions by 20 to 30 percent. (3)

Cost savings can also be anticipated from the implementation of a continuous monitoring system when used to discredit fraudulent insurance claims. In many cases, recorded incidents have simplified the process to show the fault, or lack thereof, of the

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[3] C. Simon. "Using Black Boxes to increase fleet safety and driver productivity." *Automotive Fleet,* July 2005.

involved parties. The USDOT and the FTA issued a report in 2007 that found after the installation of video surveillance technology in four Southeastern Pennsylvania Transit Authority (SEPTA) buses, there was a 32 percent reduction in insurance claims resulting in a savings of **$15 million** of SEPTA's annual legal payouts. The same FTA report also noted that when Dallas Area Rapid Transit (DART) installed video surveillance into 68 of its buses, it resulted in a 35 percent reduction in insurance claims for both accidents and injuries. [(4)]

In addition to being a benefit to the agency, video monitoring systems can benefit the vehicle operator/driver. Using recorded data, transit agencies are able to improve driver training by identifying patterns of problematic behavior both of the driver, and of customers. Continuous monitoring systems are effective in allowing the driver's primary function of moving the vehicle from point-to-point to be more efficient and safe by addressing distractions.

Initially, operators across the country were wary of the new video monitoring systems, but eventually embraced the benefits of the technology when the video was used to:

- resolve disputes,
- reduce driver harassment,
- provide indisputable evidence against onboard incidents, and
- reduce fraudulent claims.

In unionized jurisdictions, the contractual obligations might require road supervisors to follow or ride with every driver once a month for observation. Newer technology could allow for virtual ride-alongs and have the potential to change the functional role of road supervisors. By allowing for virtual ride-alongs at any time, the road supervisor can better manage subordinates and be more responsive. This situation may require a Memorandum of Understanding (MOU) to be developed between the agency and the union to adopt virtual ride-alongs in the next collective bargaining contract.

The aforementioned effects of video monitoring systems yield benefits to transit agencies through changes in human behavior both of the driver and the customers. Task 2, below, reviews the specific advantages of technological benefits.

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[4] US DOT and FTA. Security Cameras / Security Systems Factsheet: Transit Overview, December 2007

TASK 2 – EXISTING IN-VEHICLE SURVEILLANCE PRODUCTS

Through the literature review, the study team identified the technical advantages and limitations of continuous video monitoring systems and other electronic data recording technology. In addition to investigating systems using the latest technologies—multiple cameras, night vision, and real-time monitoring capabilities— the research team also compiled a comprehensive collection of technical data from 16 vendors that provide technological solutions which address Access Link's identified needs. The vendors identified by Access Link and the study team are identified in Table 1. The team reviewed 39 different products represented by these vendors, all of which are outlined in the Task 2 Technical Memorandum and are listed in Table 1 under the Model Number columns.

Table 1: Identified Vendors and Products

Company	Product Name	Model Number	
Angeltrax Bus Video Systems	Angeltrax	ACTF460	Hybrid Quest
		HC460	Hybrid Vault
		HC860	Minimicro Plus
Apollo Video Technology Systems	MRH Series	RR-MRH16	RR-MRH8
		RR-MRH12	RR-MRH4
		RR-WC300	Road Runner MRH – DVR Unit
DriveCam	DriveCam	Video Event Recorders	
iDrive	iDrive	X1	
KCI Communications	T-eye	SBX 1100	TEYE ADR300
		SBX 3100	
March Networks	5000 Series	5308 MDVR	5412 MDVR
Mobile Video Systems	MVS	SD4-3G	SSD4
Nice Vision	Safe Route	(Product No Longer Available)	
REI Bus Watch Systems	BUS-WATCH	R4001	SD40
		R8001	
Rosco Vision Systems	Dual Vision		
Safety Vision		RoadRecorder 6000 PRO	SafeDrive MiniDVR
SEON Mobile Surveillance	Explorer	MX4	DX12
	Trooper	TL2	TL4
Smart Drive	Smart Drive	SmartRecorder	
Verint Systems, Inc.	Nextiva Transit		
UTC		MVS-4-GPS	
Zen-tinel	Zen-tinel	Harrier	Hawk
		Osprey	GPAS Add – On for Harrier & Osprey

The research team successfully identified over 50 parameters of the 39 products and separated them into eight broad categories from which to evaluate each product. The comprehensive list of parameters was defined through discussions between the research team and Access Link and is shown in Table 2 below.

Table 2: Identified Product System Parameters

TECHNOLOGY	
Continuous/Short Segmented	Length of Segments
Number of Cameras	Night Vision
Wide Angle Lenses	Recording Area
Applicable to Mini-busses and Sedans	Installation Type
Audio Quality	Video Resolution
Speed Determination	GPS/Location Tracking
Direction of Travel	Integration with Google Maps
Storage Size/Requirements	Standard Size of Memory
Maximum Size of Memory	Real Time Video Link
Integration with existing NJ TRANSIT Hardware	
DATA	
Data Ownership	Technology Storage Requirements
Availability of Remote Data Access via Web	Availability of Other Remote Data Access
Ability to Download Data	Delay to Access Data
OPRA Eligibility	
DATA UPLOAD	
Wireless Hub	Cellular (3G, 4G, Other Data Carrier)
USB	Removable Hard Drive
VPN	
EVENT TRIGGERS	
G-Force	Impact
Manual (Button)	Random Events
CONTRACT INFORMATION	
Cost to Buy/Install Equipment (Capital)	Monthly Cost
Length of Contract	Minimum Fleet Size
Event Screening/Monitoring	Driver Training and Tracking
MONITORING	
Monitoring Responsibility	Filtering Criteria
Fleet Management	Real-Time Monitoring
DURABILITY AND SERVICE LIFE	
Equipment Service Life	Operability (Down Time)
Cost to Repair	
BENEFITS	
Insurance Reduction	Increased Safety
Increased Security	Driver Training
Customer Interaction Documentation	Billing No-show Fares

Table 3 summarizes five parameters deemed the most important by Access Link to meet their needs, and assesses each of the identified products against those characteristics. These critical parameters were (1) continuous recording; (2) the ability to use at least five cameras per vehicle; (3) nighttime or low-light recording; (4) recording of the area outside of the vehicle; and (5) real-time monitoring. Continuous Recording is denoted by a footnote and not given a separate column since it was uniform among all of the products offered except DriveCam and iDrive.

Table 3: Highlighted System Parameters

Table of Highlighted Parameters

		Technology			Monitoring
	Product Name	Number of Cameras (Max)[2]	Night Vision	Recording Area (Outside Vehicle)	Real-Time Monitoring
Angeltrax Bus Video Systems	ATCF460	4	Y	Y	N
	HC460	4	Y	Y	N
	HC860	8	Y	Y	N
	Hybrid Quest	8	Y	Y	N
	Hybrid Vault	2	Y	Y	N
	Minimicro Plus	1-4	Y	Y	N
Apollo Video Technology Systems	Road Runner MRH - DVR Unit				
	RR-MRH 16	16	Low-light recording	Y	Y
	RR-MRH 12	12	Low-light recording	Y	Y
	RR-MRH 8	8	Low-light recording	Y	Y
	RR-MRH 4	4	Low-light recording	Y	Y
	Optional Add-On (A)				
	RR-WC300	-		-	-
Drive Cam	Video Event Recorders[1]	1		N	Optional
iDrive	X1[1]	1	Y	168°	N
KCI Communications	SBX 1100	1	-	170°	N
	SBS 3100	3	Optional	170°	N
	TEYE ADR300	2	Y	143°	N
March Networks	5308 MDVR	8	Y	30° - 100°	Y
	5412 MDVR	12	Y	30° - 100°	Y
Mobile Video Systems	SD4-3G	4	x	Up to 180°	Y
	SSD4	4	x	Up to 180°	Y
Nice Vision	SafeRoute	NO LONGER AVAILABLE			
REI Bus Watch Systems	R4001 Four Camera/Channel	4	Y (low light)	With Optional Cameras	Y
	R8001 Eight Camera/Channel	8	Y (low light)	With Optional Cameras	Y
	SD40 Four Camera/Channel	4	Y (low light)	With Optional Cameras	Y
Rosco Vision	Dual Vision	2	Y	N	N
Safety Vision	Road Recorder 6000 PRO	10	Y (w/ infrared illuminator)	Y	N
	SafeDrive MiniDVR	2	Y (w/ infrared illuminator)	2.6mm	N
SEON Mobile Surveillance	Explorer MX4	4	Y	Y (with opt. cameras)	Optional (NJT)
	Explorer DX12	12	Y	Y (with opt. cameras)	Optional (NJT)
	Trooper TL2	2	Y	Y (with opt. cameras)	Optional (NJT)
	Trooper TL4	4	Y	Y (with opt. cameras)	Optional (NJT)
Zen-tinel	Harrier	4	Infrared illumination	Depends on Camera	Optional with wifi or 3G
	Osprey	4	Infrared illumination		Optional with wifi or 3G
	Hawk	4[3]	Infrared illumination	2.5-3.7mm	Optional with wifi or 3G
	GPS Add-On for Harrier & Osprey (A)	-	-	-	-

[1] These Technologies are Short-Segmented Recording Devices. All other technologies are continuous recording devices.
[2] Green Highlighted systems have a minimum capability of 5 cameras
[3] For *Hawk*, unit includes integrated Dual Camera but 2 additional cameras can be added as extra option.

TASK 3 – NATIONAL SURVEY ANALYSIS

The research study team designed and implemented a survey of transportation providers nationwide in the winter of 2012. The survey documented in-vehicle recording/monitoring systems used by transportation service providers in throughout the country.

The survey instrument sought respondent opinions on two critical facets associated with in-vehicle video recording/monitoring technology as outlined in Table 4 and Table 5 below.

Table 4: Comparison of Continuous Monitoring versus Short Segment Monitoring

Continuous Monitoring	Short Segment Monitoring
Generally multiple camera units per vehicle	Generally one camera unit per vehicle
Captures all activity and events from continuous video recording	Captures events in clips of 20 seconds as triggered by G Force or manual activation

Table 5: Comparison of Self-Monitoring versus Contracted Monitoring

Self-Monitoring	Contracted Monitoring
Monitoring is performed by camera system user	Monitoring is generally performed by camera system vendor or affiliate

Other topics covered in the survey focused on exploring details related to respondent in-vehicle video monitoring system usage, such as system features, perception among agency customers regarding the system, and associated legal and cost concerns.
The survey was distributed to 906 email contacts, and a total of 202 respondents from 44 states (representing their respective transportation agency or organization) completed the survey. Most represented public entities. Overall, respondents represented a diverse group of transportation provider agencies, with over 93 percent offering ADA paratransit services like NJ TRANSIT's Access Link or other demand response services. Respondents serve a broad customer base, with "persons with disability" (87 percent) being the customer group served by the greatest number of respondents.

Of the 202 total respondents, 144 (71 percent) reported they currently use in-vehicle video recording/monitoring systems. Respondents using in-vehicle video monitoring technology reported extremely positive commentary on their experiences with this technology, regardless of system manufacturer or features. The overarching theme of

the comments is that in-vehicle video monitoring systems provide information that benefits the agency, vehicle drivers, and passengers.

Survey respondent comments demonstrated that many feel their in-vehicle monitoring systems have been an “investment” that has “paid for itself” by reducing exposure to fraudulent claims and lawsuits against the agency. Highlights of the type of commentary shared include the following:

- “This is the single most important purchase any agency can make.”
- “[The system] has been one of the most value-added additions to our transit fleet.”
- “Don't know how we did without it!”
- “An excellent tool for capturing incidents and accidents.”
- “I would never order another bus without a video system.”
- “Best thing that happened to increase safety/security.”
- “Our video equipment has generally vindicated our agency and our drivers in accident or complaint situations, while identifying driver error or misbehavior so we can take effective corrective actions.”
- “They [monitoring systems] are invaluable when used to determine responsibility in customer complaints and preventability of accidents.”
- “Would not operate a vehicle without video/audio recording capabilities. The information recorded is essential in handling disputes, driver training and policy compliance, and improving customer service.”

One of the most significant features of any in-vehicle video monitoring system is whether or not it monitors continuously or via short segments. Findings demonstrated that the overwhelming majority of survey respondents (86 percent) reported using a continuous video monitoring system. A significant distinction was determined between the experiences of those using a continuous video monitoring system versus those using a short segment system. Specifically, continuous video monitoring system users cited many occurrences of their system capturing events and sequences that would not be triggered with a short segment system, including actions that lead up to an event. This additional captured footage greatly aids with event investigation and incident resolution.

The advantage of continuous monitoring is reinforced when one considers that a commonly reported issue by short segment system users was that their system had missed capturing the entirety of one or more events. This finding is not surprising since the majority of short segment system users reported the longest possible time frame for capturing footage is 20 seconds or less. Almost all survey respondents using short segment systems also reported that their systems require drivers to manually activate the record feature to capture additional footage, which can obviously be a very difficult task for a driver in distress to accomplish. Since an agency using a short segment system may not even be aware that an incident occurred, the rate of this type of failure is unknown and/or is unverifiable by the agency. Using a continuous video monitoring system can greatly aid in addressing this important safety and security interest.

The overwhelming majority of survey respondents (87 percent) reported they self-monitor their system. Two important distinctions were identified from the survey analysis regarding monitoring approaches. First, those who self-monitor definitely experienced less wait time to access the data recorded on their in-vehicle monitoring system. In fact, almost 63 percent of respondents who self-monitor experienced less than a one hour wait time to access their data compared with only 12.5 percent of those with a monitoring contract. Secondly, survey results demonstrated that staff time needed is not necessarily greater for those who self-monitor their system compared with those with a monitoring contract. Instead, findings demonstrated rather similar staff hour commitments among both respondents who self-monitor and those who have a monitoring contract. Using continuous in-vehicle video monitoring is also beneficial and offers a key advantage over short segment systems because the continuous technology has the capability to achieve critical safety and reduced liability objectives by capturing all incidents, not just the limited few recorded by a short segment system. Since Access Link in-vehicle video monitoring is used to address events involving both passengers and drivers, continuous monitoring will provide increased opportunities to gather video evidence that can help positively change behaviors and offer a tool that will greatly facilitate teaching by example.

Implementing a continuous video monitoring system for the Access Link vehicle fleet creates the opportunity to fully capture events and their associated precursors, which can help resolve incidents and achieve safety and reduced liability objectives. With regard to self-monitoring, if NJ TRANSIT opts to pursue this approach, the principle advantage will be the absolute control afforded to the agency in determining what they choose to monitor and how readily they can access the data captured. Self-monitoring would permit NJ TRANSIT to determine and implement their own data review/filter criteria and would permit immediate or rapid access to the data captured, all of which can help maximize the benefits of using in-vehicle video monitoring systems.

TASK 4 – COST– BENEFIT ANALYSIS

Cost Analysis: Request for Information (RFI) Survey

The results of the literature review and survey yielded no pre- and post- installation financial comparisons between segmented and continuous recording systems. Therefore the research team solicited, through a Request for Information (RFI), non-binding cost information in a full proposal for video monitoring systems that Access Link can implement within its fleet. Participants were provided with the full listing of vehicle types and quantities and asked to prepare their information based upon the baseline system established in Task 2 representing the parameters outlined in Table 5.

Participants were asked to prepare a detailed narrative to the items requested and provide an easy to read 1-2 page simplified version of the budget to assist NJ TRANSIT in performing a cost-benefit analysis of the features they desire. Seven companies responded, representing ten products. Some companies offered a basic overview and cost structure to their products while others offered “premium” enhancements to their base systems. This information was used to perform a cost-benefit analysis to:

- Gain a better understanding of commercially available equipment and options,
- Program necessary capital resources to implement a camera system within the full fleet, and
- Make a go/no-go decision on a full (or possible partial) paratransit fleet-wide installation.

The research team issued an RFI for a standard system, with the intent to compare similar cost data across multiple vendors. However, no segmented systems vendors responded to the RFI. In order to provide a side-by-side comparison between the continuous and segmented technology, the team used a multiplier on the current NJ TRANSIT contracts to normalize for the additional cameras. The research team acknowledges that this potentially adds error into the cost-benefit analysis, but since no segmented vendors responded to the request, it was the only way to still perform a comparative analysis. Furthermore, it is anticipated that NJ TRANSIT would receive varying pricing incentives from vendors if they were to equip their entire fleet.

The RFI also supplied an insight into the technological capabilities of the responsive vendors. Table 7 on page 18 summarizes the findings in the areas of contract information, recording technology, monitoring, event triggers, data upload, and other technologies, as detailed in Task 2. The information provided in Table 7 is given for all of the vendors that responded to the RFI compared to the current DriveCam system.

Table 6 - Technical Summary of RFI Vendors

Vendor	Product Name	Contract Information			Recording Technology			Monitoring				Event Triggers				Data Upload					Other Technology				
		Length of Contract	Fleet Minimum	Data Ownership	Continuous Segments	Short Segments	Length of Segments	Who Monitors	Filtering Criteria	Fleet Management	Real-Time Monitoring	G-Force	Impact	Manual Trigger	Random Events	Wireless Hub	Cellular (3G,4G, Data Carrier)	USB	Removable Hard Drive	VPN	Number of Cameras (Max)	Night Vision	Recording Area (Outside Vehicle)	Installation Type	Video Resolution
Apollo Video Technology Systems	Road Runner MRH - DVR Unit	Discounts apply with quantity. MSRP pricing.			-	-	-	-	-	-	-	-	-	-	-	Extra 210 Wireless LAN	Requires iPhone APP	-	-	-	-	-	-	-	-
	RR-MRH 16	N	1	NJT	Y	Y	Between 47 hours to 1506 hrs depending on ips and HDD	Self or Managed	Y	Y	Y	Y	Y	Y	Y	Add-On	Add-On	Y	Y	Add-On	16	Low-light recording	Y	Integrated System	4CIF
	RR-MRH 12	N	1	NJT	Y	Y		Self or Managed	Y	Y	Y	Y	Y	Y	Y	Add-On	Add-On	Y	Y	Add-On	12	Low-light recording	Y	Integrated System	4CIF
	RR-MRH 8	N	1	NJT	Y	Y		Self or Managed	Y	Y	Y	Y	Y	Y	Y	Add-On	Add-On	Y	Y	Add-On	8	Low-light recording	Y	Integrated System	4CIF
	RR-MRH 4	N	1	NJT	Y	Y		Self or Managed	Y	Y	Y	Y	Y	Y	Y	Add-On	Add-On	Y	Y	Add-On	4	Low-light recording	Y	Integrated System	4CIF
	RR-WC300	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Add-On	Add-On	-	-	Add-On	-	-	-	Integrated System	-
DriveCam	Video Event Recorders	-	20	NJT	N	Y	10 seconds	DriveCam	Event Trigger	Optional	Optional	Y	Y	Y	-	Y	Y	Y	Y	-	1	N	N	Windshield Mounted	-
iDrive	X1	N	1	NJT	N	Y	4 to 30 seconds & up to 250 segments	Self or Managed	Depends on NJT	N	N	Y	Y	Y	Y	Y	N	Y	SD Card	N	1	Y	168^0	Windshield Mounted	2 mpix
Mobile Video Systems	SD4-3G	N	1	NJT	Y	Y	Varies	NJT	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	N	-	4	Y	Up to 180^0	Integrated System	CIF (352x288) HD1 (704x288) D1 (704x576)
	SSD4															WIFI Optional			Y		4	Y	Up to 180^0		
SEON Mobile Surveillance	Explorer MX4	N	1	NJT	Y	N	Continuous	NJT	Y	N	Optional (NJT)	Optional	Optional	Y	-	Optional	Optional w/ Live View Box ($1000/unit)	Y	Y	-	4	Y (black and white at night with built-in infrared lighting)	Y (with Optional cameras)	Integrated System	720x480
	Explorer DX12											Y	Y								12				
	Trooper TL2											Optional	Optional								2				
	Trooper TL4											Optional	Optional								4				
UTC	MVS-4-GPS	-	None	NJT	Y	Y	Continuous or Event Driven	NJT	Y	Optional with Wireless	Optional with Cellular	Y	Y	Y	Y	Optional	Optional	Y	Y	Add-on	4	Infrared Illumination	Depends on Camera and alignment	Integrated System	640x840 VGA 320x240 CIF 162x120 QCIF
Zen-tinel	Harrier	N	1	NJT	Y	N	Continuous	NJT	Y	Y	Optional with wifi or 3G	Y	Y	Y	-	Optional	Optional	Y	Y	-	4	Infrared Illumination	Depends on Camera	Infrared System	NTSC (720x480)
	Osprey	N	1	NJT	Y	N	Continuous	NJT	Y	Y	Optional with wifi or 3G	Y	Y	Y	-	Optional	Optional	-	Y	-	4	Infrared Illumination	Depends on Camera	Integrated System	NTSC (720x480)
	Hawk	N	1	NJT	Y	N	Continuous	NJT	Y	Y	Optional with wifi or 3G	Y	Y	Y	-	Optional	Optional	-	Y	-	4	Infrared Illumination	2.5-3.7mm	Windshield Mounted	NTSC (720x480)
	GPS Add-On for Harrier & Osprey (A)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	Integrated System	-

Table 7 – Technical Limitations of RFI Vendors in NJ TRANSIT Critical Areas

RFI Responsive Vendor	Meets all requirements?	Continuous Recording	Cameras					Data Upload Requirements		Real Time Monitoring		Event Trigger Identification	Data Management	Back Up Monitor
			5 or more	Low Light	Wide Angle	Outdoor Cameras	Video Res (30 FPS)	Audio	Wirelessly (Wi-Fi)	Wirelessly (Cellular)	Web Access	Mobile Access	Event Triggers		
Apollo Video Technology Systems	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	• Manual (Driver) • Accelerometer (Additional $) • DVR / camera health events.	• NJ TRANSIT (Software provided to assist) • Managed Services offered	Yes
DriveCam	No	Unable to provide a solution meeting the RFI requirements													
iDrive	No	Yes	4 continuous, plus 2 segmented	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No real-time monitoring		• G-Force • Impact • Random • Manual	• NJ TRANSIT (Software provided to assist)	Yes
Mobile Video Systems	No	Yes	4 channel, 5 camera – forward facing camera share video channel with the rear camera	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	• Accelerometer • Impact • 16 Custom Hard-wired triggers	• NJ TRANSIT (Software provided to assist)	Yes
Saucon	No	Yes	Yes, 4, expandable to 8	Yes	Yes	Yes		Yes	Yes	Yes	Yes	No	• Speeding	• Managed solution Only	Yes
SEON Mobile Surveillance	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	• Geo-fencing • Shock sensor • Manual trigger • 5 signal inputs • Others	• NJ TRANSIT (Typical, with software provided to assist) • Possible to offer a hosted data solution	Yes
UTC	No	Yes	No, 4	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	No	• Manual trigger	• NJ TRANSIT	Yes
Zen-tinel	Yes	Yes	Yes, recommend 4 channel, 5 camera, however can accommodate additional	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	• G-Force • Speeding (Passive GPS) • DVR Health • HD Failure • Manual Trigger	• NJ TRANSIT (with software provided to assist)	Yes

Benefit Analysis: Qualitative and Quantitative Benefits

The main benefit of continuous recording video systems is that they allow for more detailed incident reconstruction than event triggered video systems. The collection of continuous recording, including pre-and-post event video data, can be used for assessment of events surrounding an incident, whether it is an accident, injury, altercation, or natural occurrence. Human error can be assessed and potential witnesses can be identified. Actions by all involved parties can be documented to assist in resolving insurance claims. Valid claims can be expedited or false accusations can be refuted. Segmented systems such as DriveCam may be appropriate and beneficial for some applications, however, the users must decide if the additional information collected by a continuous system is right for their agency. For example, segmented systems that primarily use G-force triggers may not be appropriate in situations that rarely have G-force events and that require continuous documentation of human interaction issues outside of crashes. Even though capital and maintenance costs are typically higher for installation of continuous recording systems, significant cost savings may be realized in paratransit operations.

An important benefit is the ability to record all events. Events which may not be captured in an event triggered video system, such as passenger-passenger interaction or passenger behavioral issues, can be captured by a continuous recording video system. Having video records of all events may further aid NJ TRANSIT in dispute resolution and reduce liability & claim payouts.

The qualitative as well as quantitative benefits signify that there is considerable value in implementing continuous recording video systems within the paratransit fleet. The results of the analysis are presented in the following sections.

Qualitative Benefits

Many of the benefits of a continuous recording system cannot be quantitatively estimated based on the data available. Other paratransit agencies have realized improved service metrics, increased ridership, and overall customer satisfaction with the service.

Safety and Security

Continuous recording systems can lead to increased safety and reduced aggressive driving by the operators. The drivers' knowledge that they are being recorded at all times can result in more cautious operation of the vehicle and less risky behavior. In the Decatur Public Transit System (Decatur, IL), General Manager Richard Foiles reported that the continuous recording system is incorporated into new driver education and current driver training to correct bad driving habits.

Exterior cameras have also been shown to deter vandalism or theft of a vehicle while the vehicle is parked, or other crimes against the driver when he or she is in the vehicle. Furthermore, backup (rear facing) cameras also help to reduce the likelihood of striking a pedestrian or parked vehicle while in reverse.

Customer Relations

By reducing the number of incidences and improving safety and security overall, the continuous recording video systems in transit operations can have a strong positive impact on customer relations. The use of these systems holds drivers to higher standards while providing another measure of protection, including perceived safety, to customers. In addition, the video recordings can be reviewed by the transit service operator to address customer complaints of service deficiencies.

Operations and Maintenance

Continuous recording systems have many features available, which can be used to benefit operations and maintenance of the transit agency fleet. One area of savings which may be possible is the elimination of ride-along or tailing by supervisors. Typically, transit agencies will deploy supervisors in tailing vehicles to monitor a sample of the drivers' time in service. By installing continuous recording systems, one individual in a command center may be able to monitor multiple vehicles at all times, removing the costs associated with tail vehicles (i.e. vehicle charges, gas, labor, liability, etc.).

These command center operators would also be able to collect data for driver evaluations and help drivers increase their awareness of driving behavior, as well as identify opportunities for increased customer satisfaction. There also exists the possibility that real-time intervention can be conducted if the command center identifies a serious issue with a driver.

On-board GPS provides real-time positional tracking and may be used to replace existing fleet management systems. Furthermore, vehicle maintenance may also benefit from the installation of a continuous recording system. Minor damage to the vehicles could be avoided with use of exterior cameras. Vandalism (interior or exterior) could also be reduced as cameras would discourage potential offenders.

Crash Investigations

Continuous recording systems could result in a significant reduction in effort for investigation after a crash occurs within the fleet. Considerable time and resources are spent investigating crashes. While an investigation would still take place, the addition of a video of the event, including before and after the crash, will assist the investigators to quickly understand what happened, with less expenditure of time and resources. This would result in substantial efficiencies gained within the agency via increased productivity.

Driver Retention

The use of the information from continuous recording systems can allow for identification of driver behavior issues early enough to correct them with training and coaching. The goal would be to correct unsafe driving and prevent accidents, avoiding injury and insurance premium increases. By avoiding "incidents" and actively working to correct driver behavior, there could be a reduction in disciplinary actions and terminations. The

increased driver retention would result in more experienced drivers, reduction in new driver recruitment/ training, and would yield significant savings for the agency.

Route Adherence

A continuous recording system would ensure drivers stay on-route and do not deviate for customer requested stops or errands and other personal trips. In complying with the displayed route, direct savings on fuel and time would be realized, as well as maintaining the unit availability for any re-routing or additional trips which may need to be added during the shift.

Customer Behavior

The agency may also opt to use continuous video recording to identify and address patterns and practices of customer behavior. In order to "refuse" or suspend service to someone under ADA, a pattern or practice must be established regarding customer behavior or abuse of the system. Continuous video monitoring will enable NJ TRANSIT to have documentation and defense when the need to exercise such action occurs. The presence of a continuous recording system will also help change customer behavior to help ensure that operating policies and procedures are followed.

Quantitative Benefits

In addition to the qualitative benefits of a continuous recording system there are also the quantifiable benefits. The research team reviewed published studies, contacted transit agencies, and spoke with numerous vendors however there isn't any published study which draws a quantitative recommendation of segmented versus continuous recording systems. Furthermore, no studies have been conducted detailing pre- and post-installation comparisons of segmented versus continuous recording systems.

Fundamentally, there is a significant difference in the duration of the recording lengths which would drive any quantitative analysis. On average, DriveCam, a leading short-segmented video monitoring provider, captures 4.6 minutes per vehicle per month.(5) However, continuous monitoring systems record for the full duration the vehicle is in service – which could be hundreds of hours per vehicle per month.

Both a segmented monitoring system using a g-force trigger and a continuous monitoring system would capture major collisions. However, the segmented system would be less likely to capture non-G-Force events, unless someone, such as the driver, manually

[5] DriveCam – Frequently Asked Questions (http://www.drivecam.com/resource-center/frequently-asked-questions)

triggers the unit. This limits short segment monitoring systems ability to capture non-collision events, such as customer–customer altercations, customer–driver altercations, driver risky behavior (i.e. cell phone usage), etc. This is confirmed through responses to the national survey conducted as part of this project. Specifically, 49.4 percent of continuous system users who responded to the survey identified "capturing events/sequences that would not be triggered in short segmented system" [6] and over 42 percent of respondents [with short segmented systems] report their system has missed capturing the entirety of one or more events. [7]

However, as identified through the Request for Information (RFI) effort discussed earlier, the continuous system have significantly higher costs to initially purchase than the segmented systems. Both systems effectively capture major events; the segmented system in fact captures major events for less initial purchase cost. The fundamental business decision is if the value derived from capturing additional non-g force triggered events, and capturing the entirety of a major event, outweigh the additional purchase cost of a continuous monitoring system.

Insurance and Liability

The greatest direct benefit from using continuous recording video systems is the ability to reduce or eliminate lawsuits from passengers, pedestrians and drivers of other vehicles following an incident. The system's capacity to capture and relay events at all times allows for an accurate reconstruction of what actually occurred during an incident. In addition, those passengers or others around the vehicle who may attempt to place blame upon the operator for some damage or injury without basis can be identified and the fraudulent or baseless claims can be thrown out without the high legal cost to investigate and respond in court.

Transit operators who use the systems can attest to this, James Bradford, Assistant General Manager of CT Transit (Hartford, Connecticut), reported that installation of continuous recording video systems had been "extremely beneficial" to his organization. In cases of accused liability, attorneys ask for video footage almost every time, and continuous recording allows CT Transit to waste less time on litigation associated with defending claims.

[6] Task 3 Tech Memo – Table 22, Page 22

[7] Task 3 Tech Memo – Page 24

As a more local example, in 1993:

> New Jersey set up a sting operation in which it staged and filmed more than 10 accidents around the state. Then, it monitored the claims resulting from these staged accidents. Typical of the accidents was one in East Orange, New Jersey, in 1993. A bus carrying 15 passengers, all participating in the sting, was hit from behind by a car traveling at less than 10 miles an hour. Video cameras in the bus and outside filmed 17 people, who had been bystanders when the accident occurred, scrambling onto the bus before police arrived. All later claimed to be injured in the accident. In addition, two individuals who were never on the bus, either at the time of the accident or subsequently, also filed claims. As a result, hundreds of thousands of dollars worth of claims were filed against the bus company's insurer for treatments to injuries said to stem from the accident. Transport companies in New Jersey reported that when buses had collisions in urban areas, they would often be surrounded by "runners" for doctors and lawyers who would get on the bus, hand out leaflets with phone numbers, and encourage passengers to say they suffered from back or neck injuries, which are hard to disprove.[8]

The focus of the quantitative assessment of the benefits of segmented versus continuous monitoring systems should revolve mostly around cases of liability against the transit service. These claims include both major and minor collisions as well as various other liabilities such as personal injury. Through analysis of the overall reduction of collisions (which result in claims), dismissed claims (assumed false or fraudulent), and subrogated claims (transfer of liability to third party), the research team was able to perform a comparative cost-benefit analysis.

To verify that there would potentially be a benefit for NJ TRANSIT to switch to a continuous system, the reduction in crashes will be at least equal to if not greater than the existing segmented system. Based on the suitability of a vendor to meet NJ TRANSITs needs, response to the RFI and/or the availability cost information the research team performed a comparative analysis of DriveCam to represent segmented systems as well as Apollo Video representing continuous systems. DriveCam was selected as the baseline segmented monitoring system since NJ TRANSIT currently has their system installed. Apollo Video was selected as the baseline continuous monitoring

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[8] TCRP Synthesis 36 – P. Maier. Identifying and Reducing Fraudulent Third Party Tort Claims Against Public Transit Agencies. Transit Cooperative Research Program, 2000. http://onlinepubs.trb.org/onlinepubs/tcrp/tsyn36.pdf

system because they are the number 1 supplier of transit bus mobile video surveillance equipment, serving more than 340 clients. [9] The research team cross-referenced crash data for NJ TRANSIT - DriveCam to Apollo using the National Transit Database of the Federal Transit Administration.[10] In order to better compare the crash results the team identified transit systems similar to NJ TRANSIT which have Apollo continuous monitoring systems installed. Transit systems were considered to be similar to NJ TRANSIT if they had a similar bus fleet size, in a similar type of geographical area (to account for driving characteristics), population densities, and of which sufficient data exists. From the list of Apollo clients, the research team identified two comparable transit providers – RideOn in Montgomery County Maryland, and the Greater Cleveland Regional Transit Authority (GCRTA) in Cleveland Ohio. Both of these agencies met the criteria of a service area population greater than ¾ of a Million (750K), located within 500 miles (east coast), and have had the Apollo system installed for at least 5 years (2007).

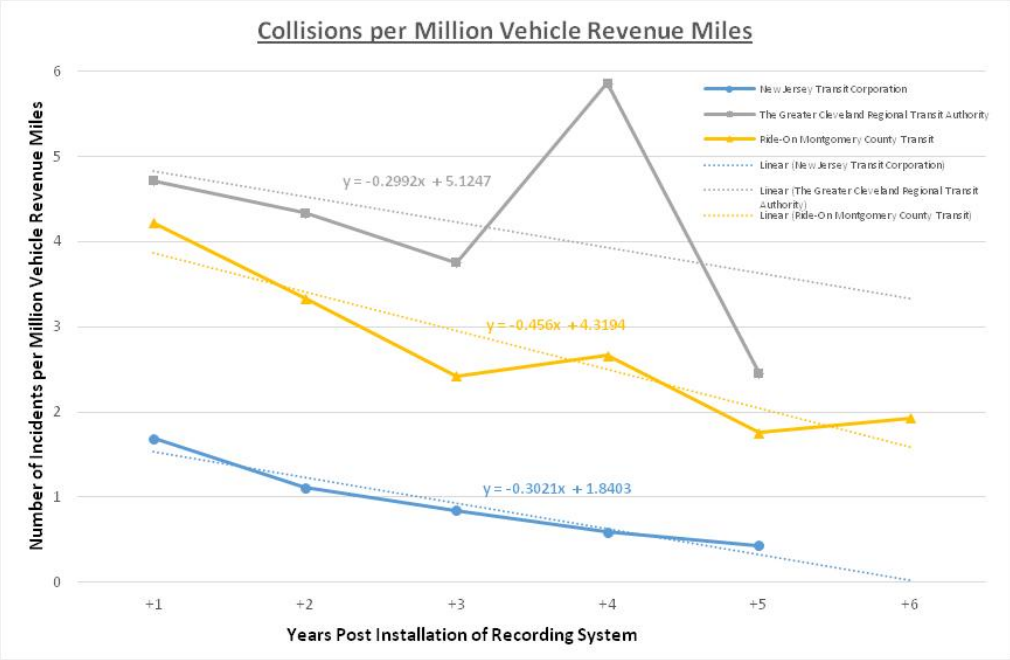

Figure 1 – Plot of collisions per million vehicle revenue miles of comparable transit agencies with Apollo Continuous Monitoring System, and NJ TRANSIT

[9] 2011 edition of IMS World Market Report for Mobile Video Surveillance Equipment http://www.imsresearch.com/report/Mobile_Video_Surveillance_Equipment_World_2011

[10] National Transit Database of the Federal Transit Administration: Safety & Security Time Series Data http://www.ntdprogram.gov/ntdprogram/

Figure 1 is a normalized representation of all the crashes for these transit systems post installation of a video recording system (continuous or segmented). All three show a decreasing trend post-installation.

As per Figure 1, the slope of Ride-on Montgomery post installation of Apollo (slope=0.456) is greater than NJ TRANSIT post installation of DriveCam (slope=0.3021). This demonstrates a greater impact of Apollo on the Ride-On system than DriveCam on the NJ TRANSIT system. Furthermore, as per Figure 1, the slopes of the trend lines show a nearly identical decrease in collisions for NJ TRANSIT and Greater Cleveland. Furthermore, there is an evident spike in the Greater Cleveland data in year four data which, from a statistical standpoint, can be considered an outlier and should be removed. If this data was corrected for the outlier it would show a more positive trend for that system as well. Although this does not prove that Apollo (continuous system) would have a greater impact than DriveCam (segmented system) it is an indicator that the continuous "could" have additional benefits.

As with any comparative analysis it is unlikely to have all the variables identical, both Montgomery County and Greater Cleveland systems have smaller service areas and service populations than NJ TRANSIT. Therefore the analysis only demonstrated an increased potential for crash reduction - an exact prediction cannot be determined.

In developing the cost-benefit methodology and in lieu of historic pre-and-post installation data to develop a comparison, the research team has developed a range of potential benefits. Since both systems capture major collisions, it is assumed that the benefit to NJ TRANSIT to switch to a continuous system will be at least equal to the existing segmented system. Regarding the upper hypothetical benefits limit, some quantitative data the research team was able to identify indicates:

- RGRTA (Rochester, NY) – "Because 75 percent of its lawsuits are frivolous, fraudulent, or exaggerated, the agency saves hundreds of thousands of dollars by using video evidence to eliminate or effectively address these claims [sic]". (11)
- Mineta Transportation Institute, 2012 TRB paper - "…transit-industry clients have seen dramatic decreases in the frequency and severity of collisions year-over-year, resulting in an overall reduction in claims' cost of 30 percent to 80 percent, and a 40 percent to 80 percent reduction in accident frequency." (12)

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[11] TCRP Synthesis 93. "Practices to Protect Bus Operators from Passenger Assault. A Synthesis of Transit Practice" P.40 http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_93.pdf

[12] Litschi, Michael. Haas, Peter. (Mineta Transportation Institute) Evaluating the Effectiveness of Video-Based Driver Risk Management Systems on Transit Safety. http://docs.trb.org/prp/13-4087.pdf

- "The systems have been a crucial component of our customer relations strategy and have led to the dismissal of nearly 80 percent of customer complaints." [13]

Therefore based on previous studies, survey results, and comparative crash trends the cost-benefit analysis will provide a theoretical range of cost savings. The lower limit (minimum predicted savings) would be equivalent to the current DriveCam system (baseline scenario). This assumes that there is no additional savings derived from upgrading a segmented monitoring system to a continuous monitoring system. The upper limit is defined as a 75 percent reduction of total costs (beyond a no system installation scenario). The upper limit assumes that the information derived from a continuous recording system fully reduces the liability from frivolous lawsuits to zero. Based on the RGRTA and Mineta Transportation Institute reports, a value of 75 percent was used.

The claims/liability analysis used national data provided by First Transit encompassing agencies across 31 states, as well as the District of Columbia and Puerto Rico to compare agencies that either have no system installed or have installed the DriveCam system.

By comparing national data for the same time period for fleets with and without a recording system installed, as shown in Table 8, there is a significant drop in the average payout per claim as well as an increase in claims that were false (dismissed) and subrogated (transferred liability to a third party).

[13] A. Himes. Letter of Recommendation of Apollo Video Technologies from Alexandria Transit Company, Alexandria, VA

Table 8 – Five years (2007-2011) of First Transit national data for fleets with and without a recording system installed

	Claims with No Monitoring System Installed		Claims with Segmented Monitoring System Installed	
	# of claims	Cost Incurred	# of claims	Cost Incurred
Valid Claims	1124	$29,861,018	1398	$12,586,408
False, Zero and Subrogated Claims	605	-	938	-
Average Payout for Valid Claims	$26,567		$9,003	
Percentage of False, Zero, and Subrogated Claims	35.0%		40.2%	

As shown in Table 9, NJ TRANSIT ($14,249) had a larger average payout per claim than the national ($9,003) average. However, the NJ system had a higher percentage of claims that were either false, zero, or subrogated. Although the NJ TRANSIT data does not directly correlate to the national data, it is statistically similar enough to use national data in the benefit analysis.

Table 9 – Five years (2007-2011) of New Jersey Transit liability/claim data post installation of the DriveCam system

	Claims with Segmented Monitoring System Installed*	
	# of claims	Cost Incurred
Valid Claims	103	$1,467,597
False, zero and subrogated claims	101	-
Average Payout for Valid Claims	$14,249	
Percentage of False, Zero, and Subrogated Claims	49.5%	

* one claim was removed as it was an extreme outlier of over $1.5M which exceed all other cumulative claims in that time period

The NJ specific data will be used as the baseline (minimum benefit) of any recording system. As discussed earlier based on supporting research the upper-limit benefit range of continuous system over a segmented system will be assumed at a 75 percent reduction (compared to a no system installation scenario). Thus a 75 percent reduction factor will be applied to the total number of claims. Table 10 shows the results of the analysis which assumes that total number of claims remained unchanged (204 claims) but the distribution of the claims and the average payout varied based on the installation of either none, continuous, or segmented system. Since there was no analytical data to support a change of the cost per claim of the segmented or continuous system this was assumed to be equal. Fundamentally, segmented and continuous systems are very different (number of cameras, length of recording, real-time monitoring, etc) which makes a direct benefit comparison impossible. The theoretical analysis in Table 10 attempts to provide a best comparison by minimizing the variables and ignoring the additional features of a continuous recording system.

Table 10 - Theoretical analysis of five years (2007-2011) of New Jersey Transit liability/claim data comparing no recording, segmented, and continuous system impacts

	Claims with No Recording System Installed		**Claims with Segmented Recording System Installed**		**Claims with Continuous Recording System Installed**	
	# of claims	Cost Incurred	# of claims	Cost Incurred	# of claims	Cost Incurred
Valid Claims	133	$3,523,220	103	$1,467,597	51	$726,674
False, zero and subrogated claims	71	-	101	-	153	-
Average Payout for Valid Claims	$26,567		$14,249		$14,249	
Percentage of False, Zero, and Subrogated Claims	35.0%		49.5%		75.0%	

The results shown in Table 10 are presented for a five year period, which is statistically long enough to average out naturally occurring annual fluctuation. Therefore annually NJ TRANSIT could expect that **without a system** they would incur a **liability/claim cost of $704,644 per year**. However, with the current **segmented recording installation** they incur a **liability/claim cost of $293,519 per year**. Furthermore, replacing their segmented system with a **continuous recording installation** could further reduce their **liability/claim cost to $145,335 per year**. This data is speculative and is statistically

sensitive to claim trends and extreme claims resulting in large one-time payouts that vary significantly from the average claim cost.

Cost-Benefit Analysis

As discussed earlier in the report, there are five parameters required by Access Link to meet their needs. These critical parameters were (1) continuous recording; (2) the ability to use at least five cameras per vehicle; (3) nighttime or low-light recording; (4) recording of the area outside of the vehicle; and (5) real-time monitoring.

Each of the alternative RFI proposals was reviewed for compliance with these five parameters and analyzed for system life cycle costs including capital investment (initial cost), which would include the price to procure, install and execute the system, as well as the operations and maintenance costs (annual cost), which would include subscription fees, maintenance and upgrades, and employee training. Based on the results, the cost benefit analysis was conducted to compare DriveCam as a baseline to Vendor1 and Vendor2. Other vendors were not considered because they did not meet one or more of the requirements of the sponsor, or did not respond to the RFI.

Table 11 – Life Cycle Costs of Baseline: DriveCam

DriveCam – Base Installation			INITIAL COST
Unit Cost	$ 495	/vehicle	$ 182,655
Accessory Kit	$ 143	/vehicle	$ 52,767
		TOTAL INITIAL COST	$ 235,422

DriveCam – Base Installation			O&M COST (Annual)
Managed Services subscription	$ 372	/year per vehicle	$ 137,268
Event Recorder Lease	$ 130	/year per vehicle	$ 47,970
FED Lease (fuel mgmt. component)	$ 33	/year per vehicle	$ 12,177
Remote Panic Button Lease	$ 12	/year per vehicle	$ 4,428
		TOTAL O&M (Annual) COST	$ 201,843

Table 12 – Life Cycle Costs of Alternative #1: Vendor1 System

Alternative #1 – Vendor1 System			INITIAL COST	
			Base Installation	Premium Installation
Continuous Recording	$ 3,049	/minibus	$ 1,054,593	$ 1,054,593
	$ 1,981	/sedan		
Cameras	$ 1,101	/minibus	$ 373,731	$ 373,731
	$ 608	/sedan		
Data Upload	$ 397	/vehicle for base installation	$ 146,493	$ 705,528
	$ 1,912	/vehicle for premium installation		
Real-Time Monitoring	$ -	Software Included	$ -	$ 6,000
	$ 6,000	Enterprise Video Streaming /fleet		
Event Trigger	$ -	Driver Event Switch	$ -	$ 92,988
	$ 252	3-axis Accelerometer /vehicle		
Data Management	Software Packages vary		$ -	$ 97,254
Back-up Cam & Monitor	$ 763	/vehicle	$ -	$ 281,547
Warranty (All Equipment)	$ -	Included 3-Year	$ -	$ 184,131
	$ 499	5-Year /vehicle		
GPS Kit	$ 142	/vehicle	$ -	$ 52,398
Installation	Not Included		$ -	$ -
Backend facility installation	Not Included		$ -	$ -
Server	Not Included		$ -	$ -
TOTAL INITIAL COST			Base Installation	Premium Installation
			$ 1,574,817	$ 2,848,170

Table 12 – Life Cycle Costs of Alternative #1: Vendor1 System (Continued)

Alternative #1 – Vendor1 System			O&M COST (Annual)	
			Base Installation	Premium Installation
Additional Data Management Services	$ 9,225	Monitoring Service, Driver Behavior /month	$ -	$ 1,050,552
	$ 3,321	Monitoring Service, Fleet DVR Health /month		
	$ 3,750	Investigative Services /50 hours		
Software Maintenance	$ 5,355	Base /year	$ 5,355	$ 19,377
	$ 19,377	Additional /year		
TOTAL O&M (Annual) COST			Base Installation	Premium Installation
			$ 5,355	$ 1,069,929

Table 13 – Life Cycle Costs of Alternative #2: Vendor2 System

Alternative #2 – Vendor2 System			INITIAL COST	
			Base Installation	Premium Installation
Explorer DX12 System	$ 4,447	/minibus	$ 1,347,441	$ 1,347,441
Explorer MX4 System	$ 2,850	/sedan	$ 188,100	$ 188,100
Wireless uploading capability	$ 355,000	/fleet	$ 355,000	$ 355,000
Training & Documentation	$ 245,000	/fleet	$ 245,000	$ 245,000
GPS Receiver	$ 295	/vehicle	$ -	$ 108,855
Additional camera (1 per)	$ 350	/vehicle	$ -	$ 129,150
Rear vision system (w/monitor)	$ 325	/vehicle	$ -	$ 119,925
DX12 Extended Warranty	$ 598	/minibus	$ -	$ 181,194
Real Time Bus Monitoring	$ 1,500	/vehicle	$ -	$ 553,500
Real Time Data Plan	$ 35	/vehicle	$ -	$ 12,915
TOTAL INITIAL COST			Base Installation	Premium Installation
			$ 2,135,541	$ 3,241,080
TOTAL O&M (Annual) COST			Base Installation	Premium Installation
			$ -	$ -

System Benefits – Reduction in Claims/Liability

As was mentioned previously, the installation of continuous recording systems has provided the transit organizations who have installed them with a drastic reduction in the number of claims and potentially the size of claim payouts. Unfortunately, many of the organizations do not track detailed liability reduction data, specifically prior to and following the installation of continuous recording systems.

Based on the results shown in Table 10, NJ TRANSIT could expect that:

- **Without a system** they would incur a **liability/claim cost of $706,644 per year**.
- Current **segmented recording installation** they incur a **liability/claim cost of $293,519 per year.**
- Replacing their segmented system with a **continuous recording installation** could further reduce their **liability/claim cost to $145,335 per year**.

Therefore the lower-limit benefit of the installation of any recording system (Drivecam, Vendor1, Vendor2, etc) would be the difference between no system and a segmented recording system (baseline) $704,644 - $293,519 = $411,125. The upper limit benefit would be the difference between no system and a continuous recording system (baseline) $704,644 - $145,335 = $559,309. This range is to provide an estimated minimum and maximum benefit based on available data.

The benefit obtained was assumed to be static over the seven years period. It could be suggested that the amount of the claims (and hence the savings) would increase each year based on national wage trends, vehicle repair costs, etc. However increases may not be directly linked to a traditional inflation rate and it was decided that the analysis would be more conservative to ignore an escalation rate.

As shown in Table 14 the current segmented system provides a positive return on investment of $1,107,539 over seven years.

To compare the existing system with other potential systems it was important to compare similar system capabilities (number of cameras, etc). As discussed earlier, the research team issued an RFI to all the vendors. The RFI was designed to normalize the cost data such that comparable systems could be directly compared. However, several vendors did not respond or did not formally respond to the RFI, including the current NJ TRANSIT vendor. In order to provide a side-by-side comparison the team used a multiplier on the current NJ TRANSIT contracts amounts to normalize for additional cameras and obtain a better comparative analysis. Even though NJ TRANSIT has indicated a 5 camera system on mini-buses and 3 camera system on sedans, from the research team's understanding these systems come in multiples of two cameras. As such, the analysis used a conservative theoretical four camera system for mini-buses and a two camera system for sedans.

Even with the addition of two cameras for the theoretical four camera segmented system for mini-buses, the benefit was assumed to remain unchanged. Regardless of the

number of cameras functionally the segmented system would remain unchanged and only record major collisions and capture several minutes of video footage per month. Furthermore, the segmented system would still be less likely to capture non-G-Force events, unless manually triggered by the driver, such as customer–customer altercations, customer–driver altercations, driver risky behavior (i.e. Cell Phone Usage), etc. A four camera segmented system is purely theoretical to allow a better cost comparison.

Table 14 – Life Cycle Cost-Benefit of a Segmented Monitoring System

	Segmented Monitoring System				
	TWO Camera Segmented Recording System based on current NJ Transit contract costs				Theoretical 4 Camera System on 303 Mini-Buses and 2 Camera System on 66 Sedans Present Value (3% Discount Rate) Net Cost-Benefit*
Year	Equipment and Maintenance Cost	Benefit Obtained	Net Cost-Benefit	Present Value (3% Discount Rate) Net Cost-Benefit	
Yr 1	$437,265	$411,125	-$26,140	-$26,140	-$385,195
Yr 2	$201,843	$411,125	$209,282	$203,213	$42,278
Yr 3	$201,843	$411,125	$209,282	$197,353	$41,059
Yr 4	$201,843	$411,125	$209,282	$191,493	$39,840
Yr 5	$201,843	$411,125	$209,282	$185,842	$38,664
Yr 6	$201,843	$411,125	$209,282	$180,610	$37,576
Yr 7	$201,843	$411,125	$209,282	$175,169	$36,444
Total			**$1,229,550**	**$1,107,539**	**-$149,335**

* NJ Transit has indicated a 5 camera system on mini-buses and 3 camera system on sedans; being that these systems come in multiples of two cameras the analysis used a conservative 4 and 2 camera system respectively.

Based on the results shown in Table 14 there is a positive return on investment for the current segmented system (DriveCam).

A four camera segmented system is purely theoretical to allow a better cost comparison; the results in Table 14 show a negative return on investments of -$149,335 which indicates that in reality it would most likely not make sense from a business model perspective. This would represent the best comparable cost to other vendors who responded to the RFI and will be used in the overall cost-benefit analysis.

The results of the cost-benefit analysis for the Vendor1 and Vendor2 which best met the criteria outlined by NJ TRANSIT is detailed in Table 15 and Table 16 respectively.

Table 15 - Life Cycle Cost-Benefit of an Vendor1 Continuous Monitoring System

	Continuous Video Monitoring System							
	Vendor 1				Vendor 1			
Year	Equipment and Maintenance Cost	Lower-Limit Benefit Obtained	Lower-Limit Net Cost Benefit	Present Value (3% Discount Rate) Net Cost-Benefit	Equipment and Maintenance Cost	Upper-Limit Benefit Obtained	Upper-Limit Net Cost Benefit	Present Value (3% Discount Rate) Net Cost-Benefit
Yr 1	$1,580,172	$411,125	-$1,169,047	-$1,169,047	$1,580,172	$559,309	-$1,020,863	-$1,020,863
Yr 2	$5,355	$411,125	$405,770	$394,002	$5,355	$559,309	$553,954	$537,890
Yr 3	$5,355	$411,125	$405,770	$382,641	$5,355	$559,309	$553,954	$522,379
Yr 4	$5,355	$411,125	$405,770	$371,279	$5,355	$559,309	$553,954	$506,868
Yr 5	$5,355	$411,125	$405,770	$360,323	$5,355	$559,309	$553,954	$491,911
Yr 6	$5,355	$411,125	$405,770	$350,179	$5,355	$559,309	$553,954	$478,062
Yr 7	$5,355	$411,125	$405,770	$339,629	$5,355	$559,309	$553,954	$463,660
Total			**$1,265,571**	**$1,029,007**			**$2,302,862**	**$1,979,907**

Table 16 - Life Cycle Cost-Benefit of a Vendor2 Continuous Monitoring System

	Continuous Video Monitoring System							
	Vendor 2				Vendor 2			
Year	Equipment and Maintenance Cost	Lower-Limit Benefit Obtained	Lower-Limit Net Cost Benefit	Present Value (3% Discount Rate) Net Cost-Benefit	Equipment and Maintenance Cost	Upper-Limit Benefit Obtained	Upper-Limit Net Cost Benefit	Present Value (3% Discount Rate) Net Cost-Benefit
Yr 1	$2,135,541	$411,125	-$1,724,416	-$1,724,416	$2,135,541	$559,309	-$1,576,232	-$1,576,232
Yr 2	$0	$411,125	$411,125	$399,202	$0	$559,309	$559,309	$543,089
Yr 3	$0	$411,125	$411,125	$387,691	$0	$559,309	$559,309	$527,429
Yr 4	$0	$411,125	$411,125	$376,179	$0	$559,309	$559,309	$511,768
Yr 5	$0	$411,125	$411,125	$365,079	$0	$559,309	$559,309	$496,667
Yr 6	$0	$411,125	$411,125	$354,801	$0	$559,309	$559,309	$482,684
Yr 7	$0	$411,125	$411,125	$344,111	$0	$559,309	$559,309	$468,142
Total			**$742,332**	**$502,646**			**$1,779,623**	**$1,453,546**

The summary of the cost benefit analysis is shown in Table 17. In general, Vendor1 would be roughly equivalent to DriveCam; however based on the upper limit of the range, Vendor1 has the potential to result in a much larger benefit. Furthermore, Vendor1 results in a significantly larger savings than the theoretical segmented 4+ camera systems.

Vendor2's lower limit is significantly less than that of DriveCam; however based on the upper limit of the range, Vendor2 has the potential to result in a larger benefit. Furthermore, Vendor2 results in a significantly larger savings than the theoretical segmented 4+ camera systems. Based on the criteria required by NJ TRANSIT and the analysis presented, Vendor1 would likely result in a larger savings with a lower potential risk for underperforming the existing system.

Table 17 – Summary of Return on Investment Analysis to NJ TRANSIT Access Link Fleet

Vendor / System	Seven Year Return on Investment	
Baseline (DriveCam)*	$1,107,539	
Theoretical Segmented Camera System	-$149,335	
	Lower Limit	**Upper Limit**
Vendor1	$1,029,007	$1,979,907
Vendor2	$502,646	$1,453,546

* The Baseline cannot be directly compared as the systems have different features and number of cameras

In addition to the quantitative savings, there are numerous immeasurable benefits which help validate the recommendation of a system-wide upgrade to continuous recording. These benefits include:

- Reduced liability,
- Reduced litigation efforts,
- Reduced investigation efforts,
- Reduced vehicle maintenance costs,
- Reduced in-person supervision time,
- Reduced driver's aggressive and unsafe driving,
- Reduced driver turnover and new driver training costs,
- Reduced noncompliance to direct routes,
- Reduced harmful customer behavior,
- Increasing customer trust, satisfaction and potential ridership.

In addition to the analysis that was conducted in this report, additional elements should be factored in when making a decision on video recording alternatives. These items include potential savings due to GPS tracking integration of the new system/fleet management, reduced labor due to the opportunity for remote driver monitoring (as opposed to current practice of supervisor tailing drivers in the field), and maintenance costs for vehicle damage associated with vandalisms and/or minor driver-inflicted damages.

Responding vendors also supplied further enhancements that are currently and/or will be available. The benefit/cost ratios performed do not reflect benefits from these enhancements for Access Link. These items include potential savings due to GPS tracking integration of the new system/fleet management, reduced labor due to the opportunity for remote monitoring (as opposed to tail vehicle management), and reduced maintenance costs for vehicle damage associated with vandalism and/or minor driver-inflicted damages.

TASK 5 – NEW TECHNOLOGIES

The research team completed a review of trends which may help to predict the market penetration of future technologies. The research team used available literature and responses from the RFI to identify future enhancements to monitoring systems in technologies and passenger applications.

Future system technologies were defined as those that would improve the performance of existing systems, integration with new products, and enhancements. Some of the functions included:

- The ability to collect passenger counts,
- Smart phone applications for mobile access by supervisors, and
- Real-time route mapping capabilities.

In addition to future system designs, the ability of these systems to be scalable to fit multiple vehicle types and agency needs was assessed. Next generation systems will be designed with minimal core components and include additional technological add-ons to provide expanded functionality. These scalable systems allow vendors to provide their clients enhanced capabilities while minimizing costs.

The potential applications for passengers may include mobile or web-based fare payment and scheduling, real-time SMS or other alerts when a paratransit vehicle is in proximity to the customer (to allow them to wait indoors), and the delivery of images of vehicles and operators prior to their arrival.

OPEN PUBLIC RECORDS ACT (OPRA)

The control of continuously recorded video data under the New Jersey Open Public Records Act (OPRA) was also investigated. There are two options regarding the governance of recorded video – in the first scenario, NJ TRANSIT would own and manage the data collected, and in the second scenario a third party would manage the data collected. It was determined there would be no difference in either scenario regarding video data collected – the data would need to be produced if requested under OPRA regardless of whether NJ TRANSIT or a sub-contractor owned or managed it, subject to data retention time frames and restrictions related to any criminal investigations in progress. Additionally, if the data is managed to the same standards, this study did not identify any difference in exposure to legal liability between the two data ownership models.

CONCLUSIONS AND RECOMMENDATIONS

NJ TRANSIT wanted to evaluate the options for upgrading their current in-vehicle recording systems to better leverage advances in technologies. NJ TRANSIT wanted to understand the available technologies and the financial implications of various technologies before investing, in order to make an informed business decision.

Rutgers investigated the technologies available on the market, in addition to conducting a national survey to identify trends in the industry. The research team found two distinct types of technologies in the market – segmented recording systems and continuous recording systems.

NJ TRANSIT currently contracts a segmented recording technology. Segmented systems such as DriveCam may be appropriate and beneficial for some applications, however, the users must decide if the additional information collected by a continuous system is right for their agency. For example, segmented systems that primarily use G-force triggers may not be appropriate in situations that rarely have G-force events and require continuous documentation of human interaction issues outside of crashes. Regardless of whether segmented or continuous recording technology is used, there is a benefit to the agency and the customers.

The research shows, that regardless of the specific vendor, there are significant benefits to a continuous monitoring system. Fundamentally, there is a difference in the duration of the recording lengths - on average, a leading short-segmented video monitoring provider, captures 4.6 minutes per vehicle per month. [14] The national survey of transportation providers revealed that 86 percent of survey respondents use a continuous video monitoring system. Nearly all operators with a continuous video monitoring system reported satisfaction with their respective system, regardless of vendor. A commonly reported issue of short segment system users (including NJ TRANSIT's current system) was that the system had missed capturing the entirety of one or more events. Continuous video monitoring system users cited many occurrences of their system capturing events and sequences that would not be captured by a short segment system, including pre-event actions. This additional footage greatly aided event investigation, incident resolution, and employee training efforts.

The results of the literature review and survey yielded no pre- and post- installation financial comparisons between segmented and continuous recording systems. Without the existence of historical cost-benefit data, the research team needed to extrapolate from available financial information because it could not develop a simple side-by-side

[14] DriveCam – Frequently Asked Questions (http://www.drivecam.com/resource-center/frequently-asked-questions)

benefit comparison. A “range” of potential benefits was developed to support a cost-benefit analysis. At the lower limit of the “range”, since all events recorded by a segmented system would also be captured by a continuous system, it was assumed that the benefit will be at least equal to the existing segmented system. The upper limit of the “range” assumes that the continuous recording system fully reduces the liability from frivolous lawsuits to zero.

Furthermore, the research team estimated the life-cycle costs of both a continuous and segmented recording system. In order to compare the costs of the existing system with other potential systems fairly, it was important to compare systems with equivalent capabilities (i.e. same number of cameras, etc). The research team issued an RFI for a standard system, with the intent to compare similar cost data across multiple vendors. However, no segmented systems vendors responded to the RFI. In order to provide a side-by-side comparison between the continuous and segmented technology, the team used a multiplier on the current NJ TRANSIT contracts to normalize for the additional cameras. The research team acknowledges that this potentially adds error into the cost-benefit analysis, but since no segmented vendors responded to the request, it was the only way to still perform a comparative analysis. Based on the results of the research, NJ TRANSIT could expect that: 1) without a system they would incur a liability/claim cost of $706,644 per year, 2) current segmented recording installation they incur a liability/claim cost of $293,519 per year, and 3) replacing their segmented system with a continuous recording installation “could” further reduce their liability/claim cost to $145,335 per year. This data is speculative and is statistically sensitive to claim trends and extreme claims resulting in large one-time payouts that vary significantly from the average claim cost.

In addition to quantifiable liability savings of continuous recording systems used for the cost-benefit analysis there are many qualitative benefits. Many benefits are difficult to quantify in dollars saved due to their relationship to employee safety, oversight, customer relations, etc. These benefits are realized in improved operational metrics, increased ridership, and overall customer satisfaction with the service.

Overall, a continuous recording system provides additional features and captures significantly more events than a segmented system. Based on the criteria required by NJ TRANSIT and the analysis presented (specifically cost data provided by the vendors), Vendor1 would likely result in a larger savings with a lower potential risk for underperforming the existing system. Due to reduced expenditures, primarily in insurance claim payouts, the cost of the Vendor1 system would likely be recouped from savings within 3 to 4 years. Likewise an investment in Vendor2 would likely be recouped in 4 to 5 years. While a continuous system will require a larger initial investment in equipment, it will afford the agency many features that are not available in a segmented system. The research showed that there could be a significant liability savings over the life of the equipment. However, this savings could be significantly different depending on vendor or optional features that add costs but also provide a more robust system with additional benefits.

The study team findings support NJ Transit upgrading the current short-segmented system in AccessLink to a continuous recording system.

IMPLEMENTATION AND TRAINING

The findings in this research study are intended to provide NJ TRANSIT with a basis for understanding the technology and options that are commercially available. NJ TRANSIT can use this information to implement a more suitable video monitoring system meeting the needs of Access Link. The study results provide justification to upgrade the video recording service across the entire paratransit fleet.

As stated previously, the research team did not identify a pre- and post- installation financial data to compare segmented and continuous recording systems. Without the existence of historical cost-benefit data, the research team needed to extrapolate from available financial information because it could not develop a simple side-by-side benefit comparison. If NJ TRANSIT decides to upgrade their fleet to a continuous recording system the opportunity would then exist to perform a pre and post evaluation. Neither the equipment vendors nor the literature, such as published reports dating back to early 2000 from the Transit Cooperative Research Program (TCRP), provided “hard” documentation of the financial benefits of a continuous system over a segmented system. A post evaluation analysis would likely benefit other national transit agencies to make a data driven decision. The research team recommends a minimum of three years of data collection after the system has been fully installed fleet wide prior to conducting this analysis.

BIBLIOGRAPHY

"8 Myths about Video Surveillance Systems" Metro Magazine, January 2007.

Apollo Video Technology. Client Reference List.

A. Dominguez Personal Interview by Cecilia Feeley. June 30, 2011.

N. Benac and J. Agiesta. "Poll: OK to Trade Some Freedoms to Fight Terrorism" Associated Press, September 6, 2011.

T. Dao. "What to Consider Before Equipping your Fleet with Video Surveillance." Metro Magazine: Vol. 15, No. 7, (August 2009), pp. 262-267.

J. Driscoll. "National Coalition for Safer Roads Releases Data Showing Red Light Camera Support Statewide" Gloucester County Times, July 7, 2011.

DriveCam – Frequently Asked Questions: http://www.drivecam.com/resource-center/frequently-asked-questions

Homeland Security Newswire, "NJ TRANSIT tests DriveCam bus surveillance system" October 26 2006. http://www.homelandsecuritynewswire.com/nj-transit-tests-drivecam-bus-surveillance-system

H.C. Gabler, D.J. Gabauer, H.L. Newell, and M.E. O'Neill. Use of Event Data Recorder (EDR) Technology for Highway Crash Data Analysis. National Cooperative Highway Research Program. Research Results Digest 298, July 2005.

D Goldgof, D Sapper, J Candamo and M Shreve. Evaluation of Smart Video for Transit Event Detection. Final Report, National Center for Transit Research Center, University of South Florida, June 2009.

W.A. Herbert. "No Direction Home: Will The Law Keep Pace With Human Tracking Technology to Protect Individual Privacy and Stop Geoslavery?" I/S: A Journal of Law and Policy for the Information Society, Vol. 2 No. 2, (2006), pp. 419-473.

J Hickman, R Hanowski. Evaluating the Safety Benefits of a Low Cost Driver Behavior Management System in Commercial Vehicle Operations: Preliminary Results. FMCSA Webinar slides. Federal Motor Carrier Safety Administration – Office of Analysis, Research and Technology. July 2009. https://www.fmcsa.dot.gov/facts-research/media/webinar-09-07-22-slides.pdf

A. Himes. Letter of Recommendation of Apollo Video Technologies from Alexandria Transit Company, Alexandria, VA.

IMS World Market Report for Mobile Video Surveillance Equipment, 2011 edition http://www.imsresearch.com/report/Mobile_Video_Surveillance_Equipment_World_2011

"Intelligent Video Surveillance Goes Trainspotting" Electronic Design, April 27, 2007.

L. Isaacs. "Transit Surveillance: Wrecks, Lies and Videotape" American City & County, January 2003 pp. 21-27.

"Judge Tosses Engineers' Lawsuit Against Metrolink Video Cameras" CBS News, June 2, 2011.P.

D Lisk. APTA Risk Management Seminar. Drive Cam. June 2011. http://www.apta.com/mc/risk/previous/2011/Presentations/Cameras-on-Board-Lisk.pdf

Litschi, Michael. Video-Based Driver Risk Management Systems: Evaluating Effectiveness at Improving Transit Safety. Mineta Transportation Institute, San José State University, June 2011.

Litschi, Michael. Haas, Peter. (Mineta Transportation Institute) Evaluating the Effectiveness of Video-Based Driver Risk Management Systems on Transit Safety. . Mineta Transportation Institute, San José State University, November 2012. http://docs.trb.org/prp/13-4087.pdf

Maeir and J. Malone. Electronic Surveillance Technology on Transit Vehicles. Transit Cooperative Research Program, 2001.

R.G. Mathias. Practices in No-Show and Late Cancellation Policies for ADA Paratransit. Transit Cooperative Research Program, 2005.

M.L. Merolli, D. Brink, P. Conran, and J. Garcia-Vieux. "Insurance Applications for Crash Data Retrieval. Legal Considerations" Collision. The International Compendium for Crash Research, Vol. 5 No. 1 (2010), pp. 36-41.

Megerian, Chris. N.J. State Police hit "Eject" on VHS. The Newark Star-Ledger. 6/19/09.

National Transit Database of the Federal Transit Administration: Safety & Security Time Series Data http://www.ntdprogram.gov/ntdprogram/

NJ TRANSIT. "NJ TRANSIT Board Approves Purchase Of 1,145 New Buses Equipped With On-Board Camera Systems" NJ TRANSIT Press Release. January 23, 2007.

NJ TRANSIT. NJ TRANSIT Board Meeting Minutes Open Session 2/9/2011.

"NJ TRANSIT Implements NICE® Digital Video Recording Solution in Nation's Largest Statewide Transportation System," NICE Systems Inc., Retrieved from http://www.nice.com/nj-transit-implements-nice%C2%AE-digital-video-recording-solution-nation%E2%80%99s-largest-statewide-transportati

NJ TRANSIT. "NJ TRANSIT to equip Entire Bus Fleet with On-Board Cameras", September 14, 2011.

R, Notbohm. “Technology Improves Public Transportation Fleet Management.” Public Risk. April 2011.

N.J. Obermeyer. “Moving Violations: Data Privacy in Public Transit.” Geographical Review, Vol. 97 No 3, (July 2007) pp. 351-364.

J. Peckels. “Transit Video Surveillance.” Mass Transit. September/Oct. 2007 pp. 24-32.

I. Radziejewski. “Video Surveillance for Transit Buses: Keeping up with Technology” Mass Transit, September/October 2006, pp. 52-58.

D. Sapper. H. Cusack and L. Staes. Evaluation of Electronic Data Recorders for Incident Investigation, Driver Performance and Vehicle Maintenance. Final Report, National Center for Transit Research Center, University of South Florida, September 2009.

D.M. Schulz and S. Gildbert. Video Surveillance Uses by Transit Rail Agencies. Transit Cooperative Research Program, 2011.

C. Simon. “Using Black Boxes to increase fleet safety and driver productivity.” Automotive Fleet, July 2005.

T. Srokanthan. “Crimes, Lies and Videotape.” Macleans. August 22, 2005.

“Study on Crash Data from OnStar Could Help in Development of Safer Vehicles” Occupational Health and Safety. October 2, 2007.

TCRP Synthesis 36 – P. Maier. Identifying and Reducing Fraudulent Third Party Tort Claims Against Public Transit Agencies. Transit Cooperative Research Program, 2000. http://onlinepubs.trb.org/onlinepubs/tcrp/tsyn36.pdf

TCRP Synthesis 38 – P. Maier, J. Malone. Electronic Surveillance Technology on Transit Vehicles. Transit Cooperative Research Program, 2001. http://onlinepubs.trb.org/onlinepubs/tcrp/tsyn38.pdf

TCRP Synthesis 90 - D.M. Schulz and S. Gildbert. Video Surveillance Uses by Transit Rail Agencies. Transit Cooperative Research Program, 2011. http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_90.pdf

TCRP Synthesis 93. “Practices to Protect Bus Operators from Passenger Assault. A Synthesis of Transit Practice”, 2011. http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_syn_93.pdf

US DOT and FTA. Security Cameras / Security Systems Factsheet: Transit Overview, December 2007. http://www.pcb.its.dot.gov/factsheets/security/secOve.pdf