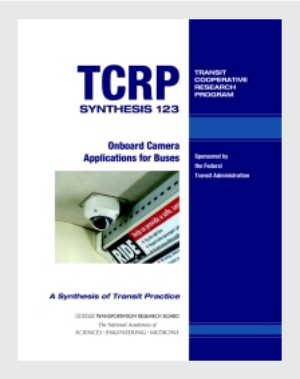

Onboard Camera Applications for Buses

DETAILS

83 pages | 8.5 x 11 | PAPERBACK
ISBN 978-0-309-44469-9 | DOI 10.17226/23554

AUTHORS

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TCRP SYNTHESIS 123

TRANSIT COOPERATIVE RESEARCH PROGRAM

Onboard Camera Applications for Buses

Sponsored by the Federal Transit Administration

A Synthesis of Transit Practice

TRB TRANSPORTATION RESEARCH BOARD
The National Academies of
SCIENCES • ENGINEERING • MEDICINE

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Onboard Camera Applications for Buses

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SUBJECT AREAS
Public Transportation • Safety and Human Factors • Vehicles and Equipment

Research Sponsored by the Federal Transit Administration in Cooperation with
the Transit Development Corporation

TRANSPORTATION RESEARCH BOARD

WASHINGTON, D.C.
2016
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TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, adapt appropriate new technologies from other industries, and introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), Transportation 2000, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program (NCHRP), undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes various transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA; the National Academies of Sciences, Engineering, and Medicine, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products. Once selected, each project is assigned to an expert panel appointed by TRB. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired effect if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

TCRP provides a forum where transit agencies can cooperatively address common operational problems. TCRP results support and complement other ongoing transit research and training programs.

TCRP SYNTHESIS 123

Project J-7, Topic SA-36
ISSN 1073-4880
ISBN 978-0-309-27221-6
Library of Congress Control Number 2016933710

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TRANSIT COOPERATIVE RESEARCH PROGRAM

are available from:

Transportation Research Board
Business Office
500 Fifth Street, NW
Washington, DC 20001

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Printed in the United States of America

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Cover figure: Onboard bus camera. *Source*: Oran Viriyincy/Flickr.

FOREWORD

Transit administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to the transit industry. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire transit community, the Transit Cooperative Research Program Oversight and Project Selection (TOPS) Committee authorized the Transportation Research Board to undertake a continuing study. This study, TCRP Project J-7, "Synthesis of Information Related to Transit Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute a TCRP report series, *Synthesis of Transit Practice.*

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Donna L. Vlasak
Senior Program Officer
Transportation
Research Board

The synthesis explores onboard camera current technologies, research, and opportunities. It provides by example how onboard electronic bus surveillance systems are used to improve operations, safety, security, training, and customer satisfaction.

The primary source of information for this synthesis was acquired through responses to a survey. Additional information is offered in a literature review and case examples.

Barbara Thomson, Iliana Matos, and Joseph Previdi, Thomson Consulting, Wyndmoor, Pennsylvania, collected and synthesized the information and wrote the report, under the guidance of a panel of experts in the subject area. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the web at www.trb.org) retains the color versions.

ONBOARD CAMERA APPLICATIONS FOR BUSES

SUMMARY

Transit agencies across the country of every size are successfully using onboard camera applications for their buses for safety and security of bus operators and passengers, and they are reaping financial benefits while doing so. This synthesis provides practical examples of the technologies and opportunities currently in operation at large, medium, and small transit agencies across the country. It focuses on their collection of the media images, what they use them for, and how they keep up with the fast advances of surveillance technology.

The study was undertaken to explore the current technologies, research, and opportunities, and to provide examples of how surveillance systems are used to improve operations, safety, security, training, and customer satisfaction. Thirty-two transit agencies responded to the electronic survey sent to 40 agencies, yielding an 80% (32/40) response rate. Based on the survey and in-depth interviews after the survey, five agencies were able to provide information for case examples of the details of their programs and their applications.

Agencies have gone so far as to say their systems are invaluable. All of the agencies that responded to the electronic survey achieved their goals of improving safety and security, as well as deterring criminal activity and reducing accident claims. Through coordination and support from multiple departments, the entire agency and public can reap the benefits from camera applications. Most important, customers and bus operators feel more secure and safer. Meanwhile, the agencies feel the impact of a reduction in legal claims payouts and decreased workers' compensation awards so much that they are measuring their return on investment (ROI).

In addition to legal and security benefits, training is improving. Agencies use the cameras for customer relations and accident prevention. One agency gives an award for accident avoidance based on video from its buses.

Although some of the agencies focus cameras at the drivers, the majority do not. They have camera views of the interior and exterior of the buses instead. The common belief is that "more is better"—place as many cameras on the bus as possible with the clearest images possible.

The programs do face challenges. Cameras focused on the operators have mixed results. The cameras can provide added security for the drivers from assaults and altercations; however, driver unions are concerned about unnecessarily monitoring bus operators, resulting in unfair discipline and added stress associated with being taped. Labor relations departments around the country have developed policies that have satisfied the unions, although one agency is going to arbitration to settle whether bus operators can be monitored during breaks.

As in most transit programs, the greatest challenge is funding. The surveillance equipment adds costs to the bus builds, and the technology changes quickly. Even so, all of the agencies reported financial benefits and increased safety.

CHAPTER ONE

INTRODUCTION

BACKGROUND

Transit agencies across the country are increasingly using onboard electronic surveillance technology on buses for the safety and security of passengers and drivers. Evolving technologies have not only recorded incidents but have helped drivers avoid hazards. Also, cameras have afforded many agencies the opportunity to affect cost savings. This synthesis, *TCRP Project J-7, Synthesis Topic SA-36 Onboard Electronic Surveillance Technologies*, documents the current use of electronic surveillance technology by transit agencies on board buses and an exchange of "what's working." It identifies technologies, research, and opportunities, and provides examples of how surveillance systems are used to improve operations, safety, security, and customer satisfaction.

The information gathered includes, but is not limited to, the following:

- Functions
- Safety and risk benefits
- Customer benefits
- Technical integration capabilities
- Maintenance
- Legal issues
- Financial impacts
- Training and labor issues.

This synthesis explores these issues and documents successful applications. The literature review, survey of selected transit agencies, and detailed case examples and profiles report on the state of the practice, including innovations, lessons learned, challenges, and gaps in information. It reports transit agencies' motivations and purposes for installing the cameras and the benefits and outcomes found. Overall, the goals of the agencies were fulfilled with added, unexpected benefits. The case studies augment and expand on the general survey to provide specific examples of how cameras are used by different agencies.

The study presents the information in a manner that will assist transit agencies as they assess current policies and identify actions that have been successful elsewhere. Finally, the study provides agency assessments of what has worked, lessons learned, obstacles overcome, and how they overcame them.

The study focuses on the collection of information from agencies across the country (plus one from Canada) on their actual applications and use of cameras. It does not include comprehensive information on the status of onboard electronic surveillance technologies on buses across the transit industry, as the survey is limited. However, agencies of all sizes from throughout the country participated in the study. Common themes across the reporting agencies have been identified.

Since 2001, when *TCRP Synthesis 38: Electronic Surveillance Technology on Transit Vehicles* was published, many transit agencies have adopted new technologies that they believe are better and cheaper than the systems used 15 years ago. Buses are now manufactured with cameras instead of being retrofit. This study does not identify brands of cameras and is not intended to promote any brand or contractor; rather, it identifies the type of technology [wireless, digital video recording (DVR), etc.] and the associated applications.

AUDIENCE

This synthesis is targeted to transit agencies with buses. Transit agencies with rail fleets may find the study useful, as well.

STUDY METHODOLOGY

To provide a comprehensive synthesis of onboard electronic surveillance technologies on buses, the study consisted of three parts: a literature review, an electronic survey, and the development of case examples to illustrate the applications of cameras on buses.

LITERATURE REVIEW

The literature review was completed to identify the current applications of onboard electronic surveillance technologies at transit agencies, providing information beyond *TCRP Synthesis 38: Electronic Surveillance Technology on Transit Vehicles* (2001) and *TCRP Synthesis 90: Video Surveillance Uses by Rail Transit Agencies* (2011). The review specifically focused on bus operations and those with recent experience, as technology and the quality of images has changed since

2001. The results from the literature review also provided insights into the development of the electronic survey and the case studies. The results are summarized in chapter three and an annotated bibliography follows the report.

SURVEY

With assistance and guidance from the topic panel, 40 U.S. and Canadian transit agencies with experience with cameras on buses were selected to participate in the synthesis survey. Transit agencies with large, medium, and small bus fleets ranging from 16 to more than 5,700 buses were included. Thirty-two of 40 contacted transit agencies completed the survey, for an 80% (32/40) response rate. (Appendix B lists the agencies.) The agencies that were interviewed and completed the electronic survey were eligible to participate in the in-depth interview for a longer case example. The in-depth interviews provided the information for the case examples and case profiles that are scattered throughout the report.

CASE EXAMPLES

Five of the 32 transit agencies that responded to the survey participated in in-depth interviews to provide case examples to demonstrate various applications of the onboard electronic surveillance technologies. They shared details of their agency's policies, success stories, and "what's working." Agencies were selected based on their responses to the survey so that as many of the report topics as possible would be represented. The case examples describe specific practices and demonstrate the various uses of the technologies. They are scattered throughout the report as case profiles and case examples. Two are highlighted in chapter five: Case Examples.

CONTENT

The report is organized as follows:

Chapter two: Literature Review

Chapter three: Survey Results

Chapter four: Challenges and Lessons Learned

Chapter five: Case Examples

Chapter six: Conclusions and Future Research

CHAPTER TWO

LITERATURE REVIEW

Currently, clear digital camera images are available in real time and can be transferred wirelessly and automatically to transit agency management and security, just as passengers have real-time transit information available to them on mobile devices. While onboard electronic surveillance technology on buses has become widespread and commonplace over the past decade, this has not always been the case. The transit agencies surveyed did not start using cameras on buses regularly until 10 to 15 years ago. What led up to its widespread use and what problems are agencies still facing?

In 2001, TRB published *TCRP Synthesis 38: Electronic Surveillance Technology on Transit Vehicles.* The report described the practice and use of onboard surveillance technologies that were designed to address both safety and security issues at public transit agencies at that time. Costs, maintenance requirements, and liability and privacy concerns were a barrier of implementation. Liability and privacy concerns have been trumped by security concerns since 9/11.

Since 2001 and 9/11, the federal government and transit agencies around the country have been focusing on security and emergency preparedness. In the 2011 *Mass Transit* article, "10 Years Later: How Has Transit Security Changed Since 9/11?" APTA's director of operations for safety and security programs, Greg Hull, stated, "Prior to 9/11 what we had in the industry were calmer approaches toward security and policing." APTA had worked with FTA to develop common approaches toward system safety, which included security and emergency preparedness; however, within hours of the attacks, senior management at transit systems and the FTA convened to discuss what needed to be put in place and what resources were available (Kaiser 2011).

> *"Among the first things that were undertaken were financial resources being put into place by the FTA for vulnerability assessments to aid transit systems in refining their security plans and tightening up any aspects that needed to be addressed."* APTA Director of Operations for Safety and Security Programs

As time went on, there were more attacks, some specific to public transit. In 2005, Daniel B. Prieto, research director of the Homeland Security Partnership Initiative and fellow at the Belfer Center for Science and International Affairs at the John F. Kennedy School of Government, Harvard University, testified before the Commonwealth of Massachusetts on "Mass Transit Security After the London Bombings," and the vulnerability of public transit to terrorist attacks. He stated the following:

> According to the Congressional Research Service, fully one-third of terrorist attacks worldwide target transportation systems, and public transit is the most frequent transportation target. Analysis of more than 22,000 terrorist incidents from 1968 through 2004 indicate that attacks on land-based transportation targets, including mass transit, have the highest casualty rates of any type of terrorist attack. On average, attacks against such systems created more than two-and-a-half times the casualties per incident as attacks on aviation targets. In terms of fatalities, attacks on surface transportation are among the deadliest, ranking behind attacks on aviation and nearly equaling fatality rates of attacks on religious and tourist targets. (Prieto 2005)

Prieto explained how there are a number of low-cost initiatives that transit agencies could pursue to improve security, including visibility of security, public awareness, and assessments of vulnerabilities. He also stated that after the Madrid bombings in 2004, transit agencies recommended *cameras and other surveillance equipment* as part of their security measures; however, the expense could pose obstacles. Other measures included interoperable communications systems, training, canine teams, and capital improvements to infrastructure.

Security is a key motivator for agencies to install video surveillance on their bus fleets. As described in a 2013 article from *Security Today*, widespread use of video surveillance has resulted from terrorist attacks throughout the years (Notbohm 2013). Within hours after the London bombings in 2005, the terrorists were arrested—largely because they were seen on camera entering and exiting the London Underground. Transit bombings such as those in Madrid (2004) and London have served to demonstrate the way transit systems can be vulnerable to terrorist attacks (Notbohm 2013). As a result, the federally funded Transit Security Grant Program invested $250 million in mass transit security. These grants help augment and improve surveillance systems, providing funding for new and improved surveillance technology that has proved to have better visual clarity as well as have the ability to obtain audio recordings of injuries, altercations, traffic incidents, and so forth.

As camera applications continue to prevail, transit agencies have found themselves grappling with issues such as funding, legal battles, and union disputes; however, they have also reaped financial benefits resulting from the cameras.

Funding for surveillance equipment is not reliable and the practices are not standard. Among the findings in *TCRP Synthesis 90: Video Surveillance Uses by Rail Transit Agencies* (Moses Schulz and Gilbert 2011), which documented the use of electronic video surveillance technology,

- Reliable funding sources are necessary to assist agencies in making more effective use of available grants to upgrade security systems;
- Policies tend to vary on how images are accessed; and
- Publicizing successful applications of video surveillance may result in diversifying funding sources for systems installation and upgrading.

As video surveillance is growing, TriMet in Oregon is currently in arbitration with its bus operator's union for installing cameras focused on the operators. Before 2010, TriMet was opposed to installing cameras until a customer recorded with his mobile phone a bus operator reading a Kindle while driving the bus. The video went viral and the operator was fired. By 2012, all new buses had eight cameras, with one specifically focused on the operator. The purpose of the camera focused on the operator is to prevent crimes and assaults committed against the driver, to further improve customer satisfaction, and to clarify false reports. Currently, TriMet is going to arbitration over whether the cameras can roll when the bus operator is on breaks or not driving (Rose 2014).

Electronic surveillance has reportedly saved Southeastern Pennsylvania Transportation Authority (SEPTA) $11 million in claims. Payouts made by the transit agency dropped by $11 million as well as an additional 5% in fiscal year 2013. In addition to the payout rate going down, the numbers of claims and lawsuits have also declined. Video surveillance provides the images plaintiffs will see in court. Lawyers who would typically sue SEPTA, considered an easier claim to collect on, now call first. The technology has changed their mentality. As of today, 75% of SEPTA's buses are equipped with cameras, and in 2016, all of their bus fleets will be equipped with video surveillance (Fisher 2014).

Massachusetts Bay Transportation Authority (MBTA) uses video surveillance to assist with legal claims and improve security. They secured a grant from the Department of Homeland Security to improve the security of its fleets. The MBTA credits the short time they have recently had to spend on closing cases to the new surveillance technology. Customer feedback surveys indicate they feel safer, which is invaluable (Clarke 2014).

CHAPTER THREE

SURVEY RESULTS

RESPONDENTS

A total of 32 out of 40 (80%) transit agencies from across the United States and Canada completed the electronic survey in 2015. They ranged in size, geographic area, and maturity of onboard electronic surveillance programs. Some have 100% of their fleets equipped; others have plans to fully equip their fleets; one small agency has not installed cameras and has no plans to do so.

These agencies are shown in the map in Figure 1.

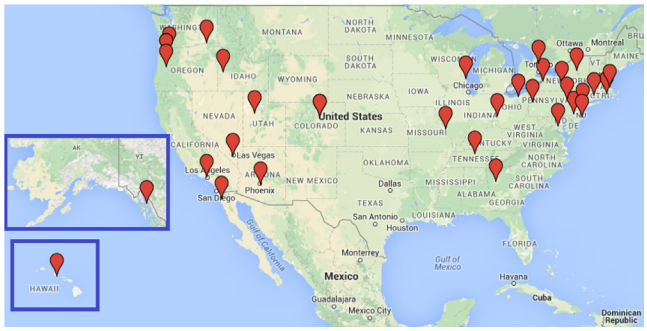

FIGURE 1 Map of surveyed agencies. *Source*: Survey results.

Sizes of Fleets

The 32 transit agencies ranged in size from some of the smallest fleets in the country to the largest, including Metropolitan Transportation Authority (MTA) New York City Transit (NYCT) and Los Angeles County MTA (Figure 2). Five (15%) of the agencies have 100 buses or fewer. One-third (34%) of the agencies surveyed have 101–500 buses.

Maturity

According to the agencies surveyed, they started equipping fleets with cameras as early as 1990 and as recently as 2014. Most agencies started to install them in 2005, after 9/11. The current trend among the agencies is to equip their fleets with surveillance equipment. With a small exception, new buses are now purchased with cameras; that trend is expected to continue.

Almost all (91%) of the agencies have buses that been retrofitted with surveillance equipment. Only one agency (3%) limited its retrofit program and did not retrofit one particular type of bus because of its age and configuration.

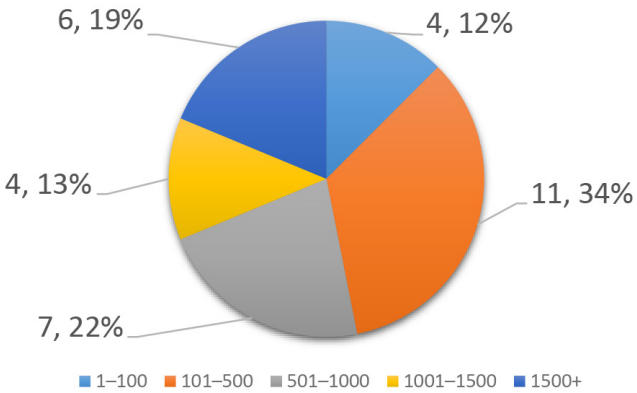

FIGURE 2 Fleet sizes of surveyed agencies. *Source*: Survey results.

Currently, more than one-half (18) of the agencies have 100% of their buses equipped and 85% (27) of the surveyed agencies have at least 75% of their buses equipped (Figure 3). Of those that are not fully equipped, 85% (27) have plans to equip all their buses between 2015 and 2020.

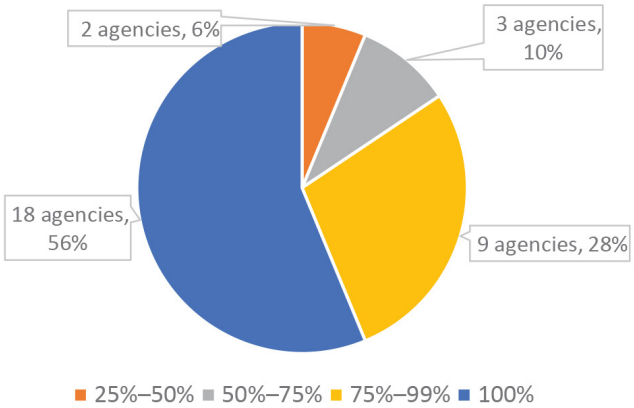

FIGURE 3 Percentage of fleet equipped with cameras. *Source*: Survey results.

FUNCTIONS

Cameras on buses have a number of functions. Agencies use them for safety purposes, accident and insurance claims, investigations, training, and passenger counting. There do not appear

to be standard policies associated with the use of the equipment among the agencies surveyed. However, the agencies have consistent reasons for installing the equipment as well as consistent associated benefits. All (100%) of the agencies have interior cameras and 25 (nearly 80%) have exterior cameras. The cameras are either running constantly (18 agencies) or are activated by the bus operator upon log-in or starting the shift.

The agencies use the images from the surveillance cameras for a variety of reasons, including safety, legal, and training purposes. Although available in real time at some agencies, the videos are typically reviewed when there is an incident. Common triggers include operator reports, customer reports, criminal incidents, and accidents (Figure 4). Some of the agencies review the videos regularly as part of a periodic audit. Although the question was asked in the survey, it is unclear from the responses how long agencies archive their video images. Many responded that it depended on whether they were triggered for review and on the legal requirement.

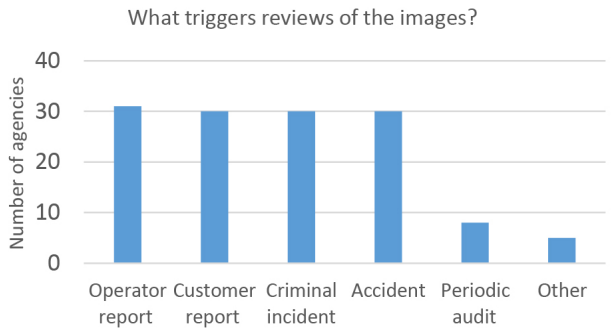

FIGURE 4 Reasons for reviewing surveillance. *Source*: Survey results.

Twelve of the agencies, less than half, reported they have a policy associated with onboard surveillance technologies on buses. Examples of policy areas include

- Safety of bus operator and customer;
- How and when surveillance is allowed; and
- Standard operating procedures for the cameras.

Transit Policy Examples

- For use in investigation into security or criminal investigations, incidents involving vehicle accidents and/or potential for claims of injury or damage to property.
- Surveillance signs on the bus must be posted in both English and Spanish.

Motivations or Purposes

There are many motivations or purposes for installing cameras on buses, of which the top five were safety related (Figure 5). Four of the top five reasons are operator safety, customer safety, deterrence of criminal activity, and part of an overall security strategy. Another one of the top five reasons is accidents and insurance claims. When adjusted based on significance (very significant, significant, or somewhat significant), operator safety and accidents and insurance claims were ranked equally.

MBTA: Video Surveillance Policy

The MBTA's video surveillance policy provides the backbone for organization. They have a detailed management policy that includes

- Retention rates of video;
- How video is stored;
- Who has access depending on operational need;
- How to request copies of video;
- Who downloads video; and
- How video is downloaded.

All of this results in knowing what video is available and provides a strict chain of custody so that it can be used for civil claims and criminal evidence.

Source: MBTA

FIGURE 5 Reasons given for surveillance implementation. *Source*: Survey results.

All of the agencies (100%) identified bus operator safety and customer safety as being among their motivations for installation of cameras. Thirty-one (97%) included accidents and insurance claims as one of their motivations. These 31 agencies gave accidents and insurance claims a more significant ranking overall.

The next group of significant motivations was not as specific as safety. These motivations included part of an agencywide plan for camera installation, operator performance, technology availability, workers' compensation reports, training, and fare evasion. Generally, the agencies are not

installing cameras as part of a citywide strategy or for passenger counting purposes. The agencywide plans for camera installation include surveillance equipment on rail fleets and at fixed locations such as stations and right of ways. Although six agencies listed "Other" as a motivation for installing cameras, none of them elaborated.

Transforming qualitative ranking to quantitative ranking was done by assigning numerical values to indicate varying degrees in the qualitative response. For example, a question on drivers was scored as follows:

- Not Significant = 0
- Somewhat Significant = 1
- Significant = 2
- Very Significant = 3

These questions were also scored to show simply whether there was some importance or no importance. They were valued as either a "0" for no importance and a "1" for any importance.

When an agency decided to install surveillance equipment on certain routes, about half of the agencies chose these routes because of criminal activity. Seven agencies (22%) put cameras on certain routes because of high accident frequency and three (9%) were concerned about traffic congestion, wanting to address bus bunching or on-time performance of buses in real time.

Benefits

The agencies reported that they met their goals for installing camera equipment. The benefits reflected the reasons for installation. When ranked for importance, the benefits were consistent with the motivations or reasons for installation, although accidents and insurance claims ranked slightly higher than operator safety (Figure 6). Customer safety was the third most significant benefit. Although agencies are not typically installing cameras as part of citywide plans, some cities have benefited from the transit agencies' programs.

"Over 90% of the video we use comes from SEPTA," City of Philadelphia Police Department

Source: SEPTA

When compared simply for importance or non-importance, the agencies responded similarly (Figure 7). The benefit of customer safety was as important as operator safety and accidents and insurance claims. Thirty-one (97%) listed customer safety as a motivator for cameras and all 32 (100%) identified it as a benefit.

Camera Views—Interior and Exterior

All (100%) of the agencies' buses have interior cameras and 24 agencies (more than 80%) have exterior cameras on the buses. The configurations and number of cameras on each bus, however, vary from agency to agency and from bus type to bus type within each agency. The agencies reported on their various configurations and views for both interior and exterior surveillance equipment.

FIGURE 6 Reported benefits of surveillance implementation. *Source*: Survey results.

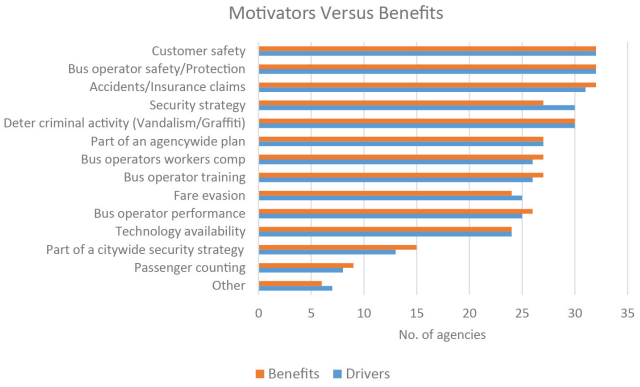

FIGURE 7 Comparison of motivators and benefits for surveillance implementation. *Source*: Survey results.

Buses with interior cameras have a minimum of two on each bus and the majority have more than six. There are fewer exterior cameras on the buses; the number ranges from one to six. The average numbers of exterior cameras for buses are as follows:

- One-door buses: two cameras
- Two-door buses: three cameras
- Three-door buses: three cameras.

The interior views on the buses are consistent with the motivators for installing the cameras. Almost all focus on safety at the doors (Figures 8 and 9). The most common view on all buses (one-, two-, and three-door) is the farebox

and front door. The second most common view is the rear door (for those that have rear doors).

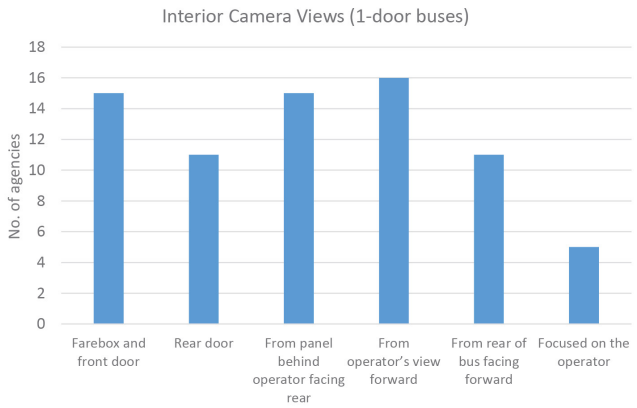

FIGURE 8 Interior camera views for one-door buses. *Source*: Survey results.

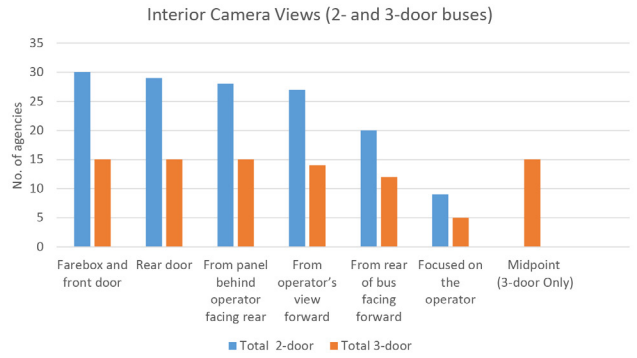

FIGURE 9 Interior camera views for two- and three-door buses. *Source*: Survey results.

At the 25 transit agencies (about 80%) that have exterior cameras on the buses, the most common view is the passenger side (Figure 10).

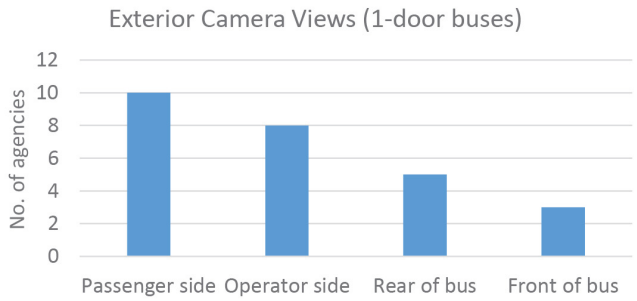

FIGURE 10 Exterior camera views for one-door buses. *Source*: Survey results.

The cameras are either running constantly (20 agencies, 63%) or are activated by the bus operator (12 agencies, 37%) upon log-in or starting the shift. According to the responses, the operators have access to the camera views while driving at only two (6%) of the agencies. These operators have interior views of the rear doors and exterior views of the passenger side and behind the bus (Figure 11). One of these agencies has a view of both the operator's side and the front of the bus.

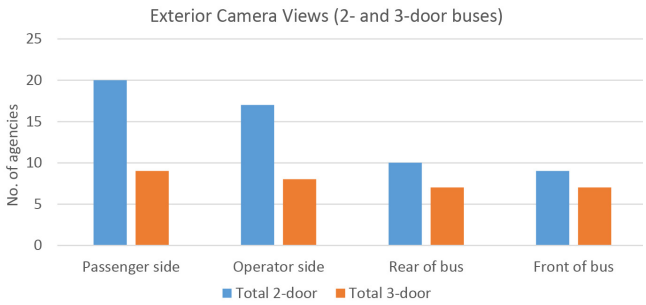

FIGURE 11 Exterior camera views for two- and three-door buses. *Source*: Survey results.

Nearly half of the agencies point a camera at the bus operators while they are driving. About a third of the agencies reported that they have agreements with the bargaining union relating to surveillance of the drivers, and half have a policy relating to surveillance of the drivers. The policies include

- No surveillance/monitoring of bus operators
- Only random/glancing views of bus operators
- Continuous view of bus operators but no "mining" for discipline reasons

Pointing a camera at a bus operator is problematic for many agencies because of labor concerns. Half of the agencies (16) found lack of union support was a significant barrier to implementation and half (16) responded that it had no significance.

TECHNICAL CAPABILITIES AND INTEGRATIONS

As technology continues to quickly change and improve, some of the agencies have more than one type of technology on their buses to record media images (Figure 12). All of the agencies protect the images they collect from unauthorized use and some are able to view the videos in real time.

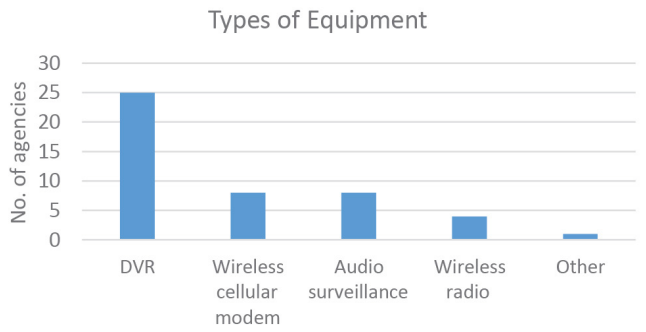

FIGURE 12 Types of surveillance equipment. *Source*: Survey results.

In most agencies, bus department management specifies the type of surveillance equipment installed. At some other agencies, the procurement department identifies the type of equipment. At one agency (3%), the legal department makes this decision.

The most prevalent equipment on the buses is DVR (25 agencies, 78%). A number of agencies also use more than one type that they have identified as wireless cellular modem and radio. Six (19%) of the agencies have audio surveillance and one (3%) is considering it. It is also important to note that some states, such as Connecticut, prohibit audio surveillance.

All of the agencies protect the video from unauthorized use. They stated that the video is encrypted (i.e., the information is encoded so that only authorized parties can read it), "read only," or protected.

Six (19%) of the agencies reported that they can view the videos in real time. The departments with real-time access include transit security, bus department management, and transit police. LA Metro is one of the agencies that can view images in real time.

CASE PROFILE: LA METRO—REAL-TIME MONITORING: MOST EFFECTIVE TOOL FOR SAFETY

To keep bus operators and passengers safe, LA Metro is purchasing all new buses with cameras as well as video monitor displays, and is even testing systems that can allow onboard cameras to be monitored in real time. The buses already have video surveillance, but LA is increasing safety, and discouraging unsafe behavior, with video monitors that will let riders and bus drivers see what's going on around them.

The intention of the systems is to decrease the number of assaults on operators and passengers. On operators alone, there were 191 assaults between 2010 and 2013. After deliberation with the bus operators and Metro, they both agreed that the new system of cameras and monitors are the most effective tools to keep operators and passengers safer.

The video also has the ability to be downloaded remotely if an incident occurs. LA Metro can also pull alongside a bus in another vehicle and get videos in real time wirelessly. Each bus will have 11 cameras mounted to it internally and externally. Video display monitors similar to those used in markets and convenience stores were recently added on LA Metro's newest buses. The agency would also like to retrofit older buses with the equipment but needs to determine how to pay for it.

The 25 agencies with DVR store on the bus the images that can be downloaded. Of these agencies, 14 (56%) can also transfer the images wirelessly and five (20%) manually transfer the videos. All 25 agencies can download the images as needed.

The time for which images stored on the bus varies among the agencies and within agencies (Figure 13). Twenty (80%) of the 25 agencies with DVR store the images there for 1 week to a month. Six (24%) download the data only as needed and the time varies. Three (12%) download the images between 24 and 72 hours. Two agencies (8%) download the images daily at a minimum. One agency (3%) stores the images on the buses for more than a month.

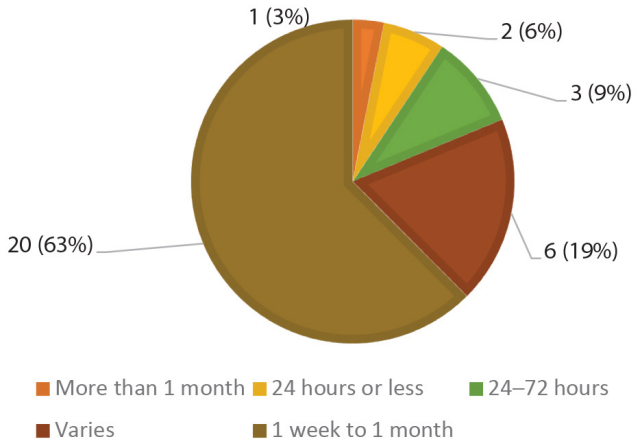

FIGURE 13 Storage time for surveillance images. *Source*: Survey results.

According to the survey question asked, management and bus maintainers have direct access to the stored images. As shown in Figure 14, it is primarily transit agency security (24 agencies, 75%) that have direct access. Bus department management has direct access at 19 (60%) of the 32 agencies; transit agency management has access at 13 agencies (41%); and the legal department has access at five agencies (16%). Bus maintainers have access at two agencies (6%), and the safety department and video security administrator each have access at one agency (3%). At all the agencies surveyed, bus operators do not have direct access to the images.

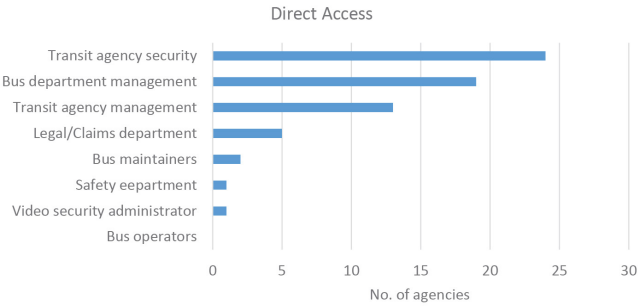

FIGURE 14 Agency departments with direct access to images. *Source*: Survey results.

Buses are becoming smarter and smarter. Many of the agencies are integrating their camera systems with global

positioning system (GPS) technology and monitors for average speed, G-force, vitals of the bus, routes, and farebox collection (Figure 15). This allows the agencies to use the cameras to help manage congestion, bus bunching, and accident investigations. It is also possible to use the camera images to investigate bus breakdowns when applicable.

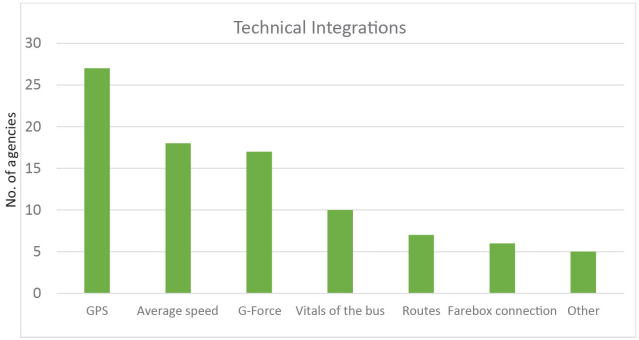

FIGURE 15 Other types of equipment. *Source*: Survey results.

Twenty-six (81%) of the agencies integrate cameras with their GPS systems on the buses. While 18 agencies (56%) integrate average speed with their cameras, 17 agencies (53%) responded that they integrate their surveillance equipment with both average speed and G-force. Ten (31%) integrate it with the vitals of the bus and fewer than six (≤19%) agencies integrate surveillance with routes and farebox collection. Nearly one-third (33%) of the agencies integrate the vitals of the buses; one agency surveyed, New York State MTA, downloads the vitals of the bus at the same time they download the videos at the fuel line. Five agencies integrated their systems with other technology; however, the other results were not provided.

CASE PROFILE: VIDEO IMAGES AND BUS HEALTH REPORTS UPLOADED DURING FUELING

The MTA New York City Transit and Bus Company has bus camera security systems on 1,728 of its buses. The systems capture video images and then upload them wirelessly at the depots while the bus is being fueled (Figure 16). At the same time, a system health report of the bus is uploaded wirelessly. A diagnostic of all the mechanical systems on the buses identifies whether there are any potential maintenance issues or reasons for extra maintenance. This all happens automatically as buses come in from their runs.

MTA's primary purpose for the electronic surveillance equipment is safety for their customers and employees. "Video surveillance is a vital element of the Metropolitan Transportation Authority's ongoing effort to maintain a transit network that is as safe and secure as possible," said MTA Chairman and Chief Executive Officer Thomas F. Prendergast when they started installation of the equipment in 2012. "Bus cameras offer a visible crime deterrent, while also providing a state-of-the-art electronic tool that will aid in the investigation and prosecution of criminal activity aboard the vehicle" (MTA 2012).

FIGURE 16 MTA camera views. *Source*: MTA New York City Transit

MAINTENANCE

The camera systems, in general, self-diagnose; however, they require regular inspection by bus maintainers. From this point of the survey forward, there were 31 responses. The percentages are therefore based on a total of 31 agencies. Twenty-four agencies (77%) stated that their systems self-diagnose and this happens on either a continuous or a daily basis.

Maintenance of the systems is predominantly the job of bus maintainers. Meanwhile, many (11, 35%) of the systems are relatively new and are still under warranty. Six agencies (19%) hire contractors to maintain the systems. To address maintenance issues, agencies mandate preventive maintenance programs, keep daily reports, and constantly train the bus maintainers on the systems so that they are always operating.

LEGAL AND LABOR RELATIONS ISSUES

The transit agencies use the videos for safety and security reasons, as well as discipline of bus operators in a few agencies. To maintain the integrity of the videos for investigative and legal purposes, 25 (81%) of the agencies maintain a chain of custody (CoC) (Figure 17). The CoC is the procedure used to show how the video was made, transferred, and saved, ensuring there was no tampering with the images.

Chain of custody (CoC) refers to the chronological documentation or paper trail, showing the seizure, custody, control, transfer, analysis, and disposition of physical or electronic evidence.

At about half the agencies, the security department is responsible for maintaining the CoC. Otherwise, bus depart-

ment management and the legal department are responsible for it, as shown in Figure 17.

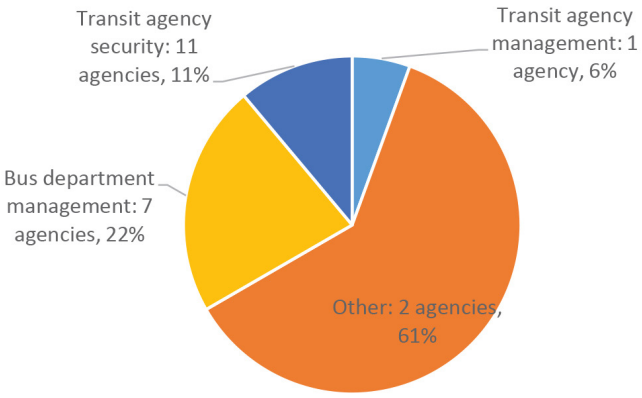

FIGURE 17 Chain of custody. *Source*: Survey results.

At 15 agencies (48%), the bus operators are monitored while driving. At most agencies, this is not the case and there are policies prohibiting it. Nevertheless, six (19%) agencies reported operators may be disciplined as a result of the video. At more than half the agencies (17), union representatives are involved in developing the surveillance policy. There are policies at two agencies (6%) that do not allow management to intentionally view the videos for discipline purposes.

Surveillance Policy

"For security, safety, and supervisory purposes, the Employer reserves the right to install and operate video and audio recording systems in all Valley Transit vehicles and facilities. Audio records shall not be used for the purpose of Valley Transit disciplinary action unless related to the commission of an illegal act by the employee."

Source: Valley Transit, Washington State

Although the responses to the surveys came from management, focusing the cameras on the bus operators may be a problem for the bus operators and their union representatives. Agencies place the cameras in the buses to ensure safety; nevertheless, union representatives are concerned about the abuse of using the videos to treat operators unfairly, resulting in discipline. Union representatives are also concerned about the added stress that comes from constantly being monitored while working. The survey suggests that agencies have dealt with this issue by enacting policies that do not allow management to discipline operators based on the videos or allow drivers to be "watched" when they are not driving the bus.

TRAINING

Twenty-seven agencies (87%) reported that they use the videos for training bus operators. Seventeen (63%) of these 27 agencies use them for accident prevention and 16 (59%) use them for customer service. The videos document incidents and assist operators to develop safer, more efficient driving habits. One of the agencies presents awards to bus operators for accident avoidance.

FINANCIAL IMPACTS

Despite the cost of installing cameras on buses, all but two agencies (6%) reported financial benefits, with reduction in accident claims and payouts being the greatest. Others included fewer workers' compensation claims, as well as fewer grievances submitted to labor relations because the evidence was clear in the video.

When the agencies were requested to identify the costs associated with installing the cameras, most agencies did not know the actual cost. The cameras were part of new bus builds and/or they were purchased more than 10 years ago by other departments and records were not reliable. The costs varied widely and there was no adjustment for inflation or buying the cameras in bulk quantities.

When reported, the cost to install cameras on new buses was much more consistent than the cost to retrofit. According to the responses, the average cost to install camera equipment as part of a bus build was $9,800 per bus and the average cost to retrofit was $9,000. On two-door buses, the average cost was $9,400 to install on new buses and $8,600 to retrofit. For three-door buses, the average costs were $12,000 and $12,300, respectively.

The cost to retrofit one-door buses ranged from $4,000 to $14,000 each. On the two-door buses, the cost ranged from $5,000 to $17,000 per bus, with one low cost of $2,700 per bus. The three-door buses ranged from $10,000 to $18,000 to retrofit, with a low outlier of $4,000. It is important to note that these costs do not necessarily include the hardware such as servers in depots or the equipment used to view the videos. Although this study provides *ballpark* costs of installation, further research is required to compare costs of systems. Regardless, agencies still find that the financial benefits outweigh the cost of installation, as demonstrated in the case examples in chapter five.

CHAPTER FOUR

CHALLENGES AND LESSONS LEARNED

The agencies stated they have achieved their goals associated with onboard electronic surveillance technologies on buses. They have had challenges since these programs started in the early 1990s, but they have overcome them, and the survey provides lessons learned to those considering installation or facing similar challenges.

Challenges agencies faced included the following (Figure 18):

- Cost to install and maintain
- Employee/union acceptance
- Equipment reliability

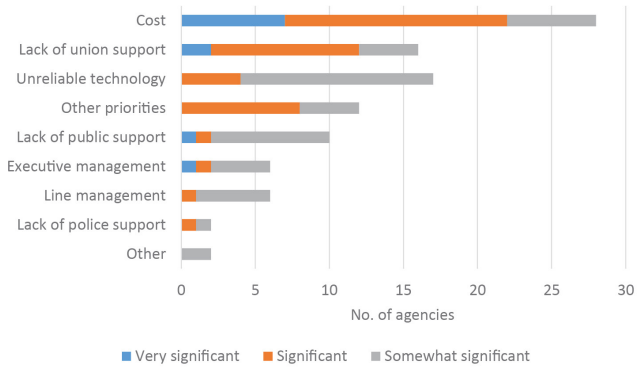

FIGURE 18 Barriers to implementation. *Source*: Survey results.

Other challenges that agencies mentioned specifically include the following:

- Maintaining older equipment and more than one type at the same time
- Replacing obsolete equipment.

The agencies ranked their greatest barriers to implementation, with cost being the most significant.

CHALLENGES OVERCOME

Agencies overcame the cost of installing and operating onboard camera systems by receiving federal funds and grant funding, and by receiving a return on investment (ROI). The systems add cost to a new bus and in some cases new servers in the bus depots, as well as equipment for viewing. Nonetheless, agencies overcame the challenge by being strategic and prioritizing the systems within their budgets, and by getting executive support for the programs.

Union acceptance has been gained by demonstrating that the systems help the bus operators and by working closely with the labor union representatives. Customer complaints have decreased. In many instances, bus operators have been investigated after certain incidents and surveillance video has proved the customer complaints have been unfounded. Agencies reported that being open and transparent was very important. One agency rewards the operators for collision avoidance.

Surveillance equipment reliability improved as preventive maintenance practices were developed either in house or by contractors. Maintainers were properly trained and the equipment was inspected on a regular basis. In some cases, the equipment is self-diagnosed. The bus is then "tagged" and brought into the depot for service.

Maintaining older and obsolete equipment can be difficult, especially when there are various types of surveillance equipment at one agency. To overcome this obstacle, agencies have standardized the equipment on their fleets to one type and worked with specific vendors. Maintaining good relationships and partnerships with the vendors has also been very helpful. In some cases, agencies have identified the camera systems and only use one source for them.

Furthermore, equipment technology has improved over time. As the technology has advanced, there have been needs for advancement on the transit agencies' networks, as well. In one situation, the agency was able to increase the bandwidth so that transmitting the information would not shut down the system. However, the increased bandwidth came at a price: increased network and server costs.

LESSONS LEARNED

All of the agencies found that cameras are an important, vital tool in the security of employees and riders. Communication is key for managing, training, and developing policies throughout the organization. The agencies recommend the most current, clearest camera images and maximizing the

number of cameras installed on buses instead of minimizing them. The most often reported lessons learned include the following:

- Onboard camera applications have agencywide impact and become invaluable.
- Standardize the systems on the buses.
- High-definition cameras are most effective.
- Maximize the number of cameras.
- Find a system that is easy to use and reliable.
- Work with the union as soon as possible for buy-in.
- Dedicate staff to review video.

As reported, a number of the agencies also suggest that they continue to work with union representatives to focus the cameras on the bus operators for their safety. One of the agencies recommended using a nonproprietary server so that it would be possible to upgrade equipment using the same server. Another agency reported that its equipment is sensitive to high temperatures during the summer and that proper ventilation and maintenance are required during these months.

Technology continues to improve, and it is important to have a plan for upgrading the systems and taking advantage of the fast-paced improvements.

CHAPTER FIVE

CASE EXAMPLES

Onboard electronic cameras on buses have had an impact on the way transit agencies do business. SEPTA and MBTA provided inside in-depth reports on what makes their systems invaluable.

CASE EXAMPLE: SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY

SEPTA, the sixth-largest transit property in the country, serves five counties in and surrounding Philadelphia and extending into New Jersey and Delaware. There are 1.2 million daily riders and 330 million per year. Nearly 80% of its buses, trains, and trolleys are currently equipped with cameras. Its bus fleet is its largest, with 1,356 buses and 87% (1,245) of those already equipped with seven to 10 cameras each. SEPTA is continuing to equip each vehicle and by the end of 2015, it expects to have more than 10,000 cameras on buses alone. There are currently more than 16,525 cameras functioning on the SEPTA system.

Video System Pays for Itself

"When you're on SEPTA, you're on camera," says James Jordan, former general counsel of SEPTA's Video & Evidence Intel Center, which resides in its Legal Division, the Office of General Counsel, provides significant savings for the agency. Aside from the video programs' primary Homeland Security purposes, the authority's claims and litigation expenses have been on the decline and have saved SEPTA more than $40 million annually. These expenses are decreasing every year, by as much as $11.5 million in fiscal year 2013. This is a sizable return on the $50 million systemwide investment to equip vehicles and stations with video systems. According to SEPTA, the key is that the video surveillance program is being managed by the Video & Evidence Intel Center within the Office of General Counsel.

Over time, SEPTA has spent more than $50 million on systems that include onboard vehicle monitoring and fixed systems, at places such as stations and rights of way. It invested $25 million in mobile monitoring with $16 million from the Department of Homeland Security and $9 million from its capital budget. Another $25 million for fixed stations came from its capital budget.

SEPTA's Video & Evidence Intel organization, one of five departments within the Office of General Counsel, opened for business just over 2 years ago and immediately set a goal to minimize accident and insurance claims, a recognized problem since the 1990s. The cameras are constantly watching as the DVR on each vehicle records video during revenue service. When an incident occurs, the vehicle operator notifies the control center of the incident. When that vehicle returns to its home location, any video of interest is sent over SEPTA's network directly to the district office server and thereafter to the Video & Evidence Intel Center at SEPTA's headquarters (Figure 19).

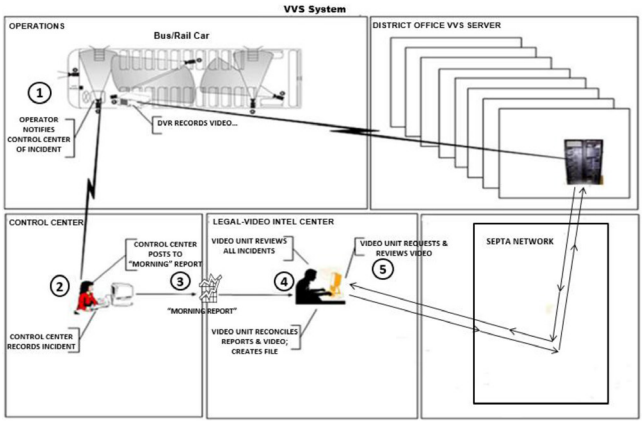

FIGURE 19 SEPTA camera network. *Source*: SEPTA.

The control center records the incident and posts it to the "Morning Report" so that the Video & Evidence Intel Center can

- Review all incidents,
- Request and retrieve video for review and analysis, and
- Reconcile reports and video, creating a file typically within 24 hours of the incident and long before most claims even materialize.

SEPTA also uses video surveillance to help with security and operations compliance. Although 90% of the videos are used for legal purposes, 9% assist the Transit and City of Philadelphia Police, and 1% support customer service and

operations compliance. (Figure 20). The City of Philadelphia Police Department has stated, "Over 90% of the video we use comes from SEPTA."

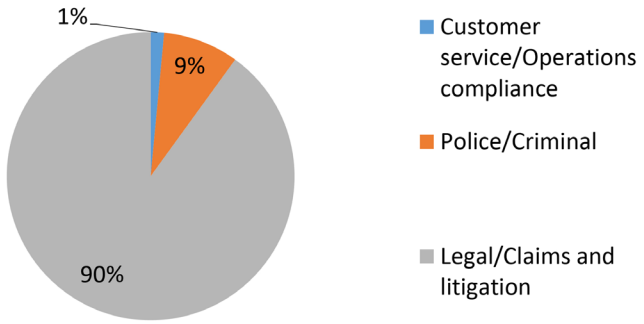

FIGURE 20 SEPTA video systems customers. *Source*: SEPTA.

The Future

Not surprisingly, SEPTA has a strategic vision to maintain its success. The vision focuses on expanding, sustaining, and refreshing dated equipment as technology continues to improve as part of SEPTA's Technology Refreshment Program. SEPTA is securing funding to equip the remaining fleet and expand coverage at stations.

SEPTA is committed to safety and security and will continue to coordinate its efforts with law enforcement throughout the city of Philadelphia, the district attorney's office, the Federal Bureau of Investigation, and others. When the pope visited Philadelphia in September 2015, SEPTA was part of the city's overall security effort—using cameras in key locations.

SEPTA will not only continue to coordinate with other agencies, the camera program will be coordinated among other technology efforts at SEPTA. As SEPTA's Key Card (New Payment Technology) is rolled out and Smart Stations become active, the surveillance program will be integrated with these efforts and others that benefit from SEPTA's legal model that has worked so well.

Storage and data migration is of utmost importance for SEPTA, especially as the agency approaches surveillance cameras from a legal perspective. SEPTA reconciles all the systems reporting with video. And Pennsylvania's 2-year statute of limitation for initiation of claims requires SEPTA to store video of interest for 2 years. Thus, SEPTA is constantly focusing on metadata collection, retention, and utilization. It is always improving on what it has, by enhancing and tightening policies, procedures, and practices on authentication, CoC, cataloguing, and preservation.

As a video surveillance leader in the country, SEPTA recommends: "Stick with what works," which for them has been their legal model.

CASE EXAMPLE: MASSACHUSETTS BAY TRANSPORTATION AUTHORITY

Game Changer for MBTA: Video Technology

Personal communications with Randy Clark and Karen Burns at MBTA provided the following in-depth look into their technology on board buses and its invaluable impact.

Today, MBTA operates a massive fleet of sophisticated vehicles including buses, subways, commuter rails, and ferries in the greater Boston area. The entire mass transit system accommodates more than 1.3 million passenger trips each weekday, ranking the MBTA as the nation's fifth-largest mass transit system.

When a Department of Homeland Security grant was secured to improve the security of its fleet, MBTA appropriated funds for a first-phase upgrade for video surveillance technology aboard 225 of more than 1,100 buses, which serve 180 routes throughout the city (Figure 21). The existing video surveillance systems on board buses were much older and offered limited video quality.

FIGURE 21 MBTA on-bus monitor. *Source*: MBTA.

Kenneth Sprague, deputy chief, MBTA Investigative Services Division, explains that retrieving the video was also a much longer process:

> If an incident was reported, we would have to go to the bus to retrieve the hard drive, and then download it at the crime scene unit. We also only had 40 hours before the digital video recorder would overwrite video; so, if something happened on a Friday evening, we would have to send someone out over the weekend to retrieve the video. It was time-consuming and inconvenient for our team.

With consultancy services, a detailed request for a proposal was submitted for public tender that stipulated specific

requirements and the need for a working proof of concept. After careful consideration, MBTA chose a system that met budgetary and technical specifications—the latter included access to live video from the operations control center (OCC), automatic offloading of video to long-term archiving when buses reached the terminals, police officer data access to nearby bus systems by means of cruiser mobile terminals, and a few other custom applications.

Simplified Video Access Provides Clearer Views on Buses

To date, the upgraded video surveillance solution has been installed on 225 buses. Each bus is outfitted with two 360-degree cameras—one interior-fixed high-definition camera and three external 720p high-definition cameras. Video is continuously recorded and stored on each of the bus's network video recorders. To support the sophisticated infrastructure of this application, Ethernet switches were selected for industrial-grade reliability, network redundancy, and seamless integrated security. On the bus, a monitor displays a live camera feed to passengers, acting both as a public advisory of video monitoring and as an added deterrent against criminal activities.

"Leveraging the security technology to promote an innovative and interactive public advisory forum allows us to encourage passengers to report incidents on the bus," explains Adam Peters, Transit Security Projects Administrator at MBTA. "A message displaying 'See something? Say something' alongside a phone number for the MBTA police is displayed below the video feeds. Passengers can also use an interactive app from their mobile device to anonymously and discretely report events. Often the messages are tweeted. This gives our community a voice and allows them to become actively involved in keeping our city safe."

Two departments within the MBTA have live access to the system from their own control rooms, including the OCC (see Figure 22) and the MBTA police dispatch. MBTA transportation executives also have system access.

FIGURE 22 MBTA operations control center. *Source*: MBTA.

What makes the installation one of the most unique in the country is the dual-mode radio that allows for simultaneous wireless and 4G LTE connectivity. This has led to the most notable advantage of the surveillance system for the bus fleet—multiple ways in which the video can be easily accessed. For example, in the event of an incident, dispatchers and analysts can view video from the bus through the cellular 4G LTE connection, facilitating both real-time emergency responses and investigations.

"Recently, there was a report of an assault on a bus driver and the dispatcher was able to pull that bus's cameras up and quickly identify the suspect," Deputy Chief Sprague says. "Within minutes, responding officers had a full description and were able to apprehend the suspect. Video surveillance onboard our buses has definitely made our jobs easier and has been an invaluable tool to law enforcement."

Leveraging the LTE connection is also an invaluable part of the investigative process for customer service agents and operators who need to quickly identify the specific time periods of video for passenger disputes or criminal investigations. Instead of guessing or transferring massive amounts of data over the LTE connection, users can simply view video through the LTE connection, identify which segments are required, and submit the transfer request.

The transfer itself is facilitated through a customized video requester tool that has simplified the retrieval of video on board buses for long-term archiving. Once the bus is back at the terminal, the system will automatically offload the video to the central archiver through a wireless network and instantly e-mail a notification to the requesting operator once the transfer is complete. This automatic video offloading helps minimize bandwidth consumption and storage, enabling MBTA security teams to keep only the video they need.

"We do a significant amount of forensic video analysis for other agencies, such as the Boston Police and Massachusetts State Police to pull events that happen at intersections, bus stations or anywhere else around the buses," says Jonathan Wing, video analyst, Criminal Investigation Unit. "It's not just about the safety of the bus drivers and passengers, but really a benefit to the whole metropolitan Boston area."

To ensure the preferred connection mode is in use at all times, integration between the video system and the GPS technology was developed. The video system is able to automatically decipher which mode of connection should be in effect, depending on the location of the bus. For example, when a bus is driving through the city, the cellular network is used to transfer video; but once a bus is within the terminal's vicinity, wireless communication takes precedence. The GPS integration is linked to the master OCC system and Google Maps, letting operators know exactly where buses are within the city.

Custom Applications Ensure Continuous Uptime and Enhance Bus Safety

Implementing the full solution was a massive team effort from the start. The MBTA security and bus departments worked with technology consultants to deliver the complete solution, combining engineering and development expertise to meet the very specific requirements.

Everyone came together to push the technological boundaries of the chosen solutions in the mass transit implementation. This was further enabled by the use of an open and mature software development kit, which allowed for more custom applications to be developed.

From mobile data terminals (MDT) in police cruisers, officers can tap into a nearby bus's video surveillance system in the event of an emergency. "It's a great safety feature for the officers on the street because they know what they are walking into," Sprague says. "They are more prepared to address the situation and to protect themselves."

When there's a possible emergency, a bus scanning tool enables law enforcement officers on the road to identify buses in the vicinity of their cruiser. To enable this feature and protect the access privileges to this functionality, each bus is correlated to hidden Session Initiation Protocol, which is stored in a database on MDT and automatically updated each time the cruiser returns to its station. Officers simply need to press a "scan" button to retrieve a list of buses within a certain range of their vehicle and select a bus number and automatically connect to the system to see what is happening before responding to an emergency.

Another application was specifically developed to help bus drivers alert OCC operators of distress on board the bus though integration of a panic button alarm. The bus driver (Figure 23) has control of the panic button, which prompts an alarm at the OCC. Operators can then click on the alarm to automatically connect to video surveillance system to see what is going on.

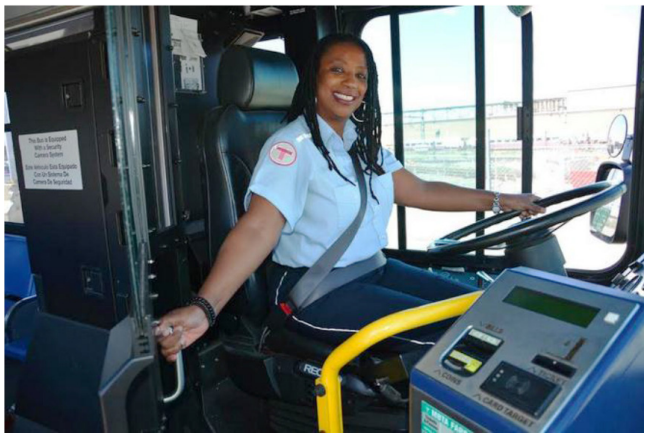

FIGURE 23 Operator controls panic button. *Source*: MBTA.

The consultant also developed a customized health monitoring and management tool. A health diagnostic report is automatically e-mailed to the team every day to ensure all bus systems are fully functional. This report helps MBTA plan for any required maintenance and ensures operators and analysts will always have access to needed video.

Beyond that, MBTA can perform remote troubleshooting and system maintenance for the various subcomponents in the bus from a dedicated support center as part of a comprehensive maintenance program. For example, there is an advanced interactive browser-based interface that provides real-time alert notifications of system health, bus location, engine status, and the status of every camera and component within the surveillance system. The system also offers the capability to push firmware and software updates, to conduct remote system troubleshooting, and to reset any system. This allows MBTA to tap into any bus system and address issues while the buses are moving through the city from a web-based client interface or smartphone, ensuring a very high degree of reliability and service.

Onboard Surveillance Leads to Greater Operational Efficiency and Safety

Camera applications had a significant organizationwide impact, from a police, legal, and safety standpoint. "The new onboard video surveillance system has helped us improve our customer service and general operations," Peters says. "Upon receiving a customer complaint such as a slip-and-fall claim, our customer service agents use the video as a tool to verify if the events had or had not taken place, and to validate the details of the incident. With this process in place, we operate the bus service in a fair, ethical and safe manner for the public."

From a safety standpoint, the onboard system represents a constant reiteration of the following advantages:

- Immediate access to video on board buses in the event of an emergency
- Instant access to nearby buses for responding officers for better preparedness
- Quicker and easier investigations for criminal activity or claims
- Improved bus driver and passenger safety throughout the fleet
- Deterrence of vandalism and random acts of violence
- Enhanced investigation abilities for increased citywide safety.

"We might not see the actual crime take place, but there is usually activity that leads up to a crime," Sprague says. "Whether it's identifying a car in the vicinity or verifying a suspect's alibi, we have the ability to view, validate and retrieve information in a timely manner. That's a huge asset for our team's ability to gather video for forensic evidence and keep this city safe."

Gradual Expansion Continues to Benefit Multiple Departments

As MBTA is in the process of upgrading another 60 buses, their long-term objective is to gradually enhance the video surveillance systems on all 1,100 buses. Meanwhile, the system's architecture has been extremely beneficial to their organization, helping to manage all systems as one from two centralized locations while still preserving departmental autonomy in their day-to-day operations. This capability encompasses fixed and mobile video surveillance systems across the entire organization and all fleets, reaching terminals, yards, administration buildings, and other mass transportation vehicles for a bird's-eye view of MBTA's entire operations.

"All of our service and technology partners have played a pivotal role in providing our mass transit organization with impressive capabilities," Peters says. "This concerted group effort has allowed our departments to respond to various incidents at moment's notice, and to see what is happening in real-time. This system is vastly more effective than what we had before."

The number of cases that MBTA have been able to close in such a short period of time truly proves the value of this system. Furthermore, customer and driver feedback shows that they feel safer. Being able to keep people safe by deterring various types of incidents or to extract evidence is invaluable (Clarke 2014).

CHAPTER SIX

CONCLUSIONS AND FUTURE RESEARCH

This synthesis documents the current use and state of the practice of electronic surveillance by transit agencies on board buses, as well as demonstrates the great potential of camera applications for buses. It identifies the technologies, research, and opportunities associated with cameras on buses. Most important, it demonstrates what is working on a large and small scale throughout the country and identifies where agencies are currently focusing their attention. It also shows that small and large agencies identified similar benefits, are facing similar issues, and have similar technology in place (digital video recording, or DVR).

All the transit agencies that responded to the survey (32 of 40, 80%) indicated that the camera applications for buses enhanced their agencies and have led to financial benefits. In agencies that have embraced them systemwide, cameras have changed the way they do business; and they have even paid for themselves. Cameras improved operator and customer safety and decreased the costs of legal claims, and the agencies have been able to integrate this technology with their other technologies. The issues with which the agencies are currently struggling focus on keeping up with the technology as it advances, recording the bus operators while driving, and paying for the systems.

The benefits of camera systems on buses are consistent among the agencies surveyed. The systems provide value to the entire organization, from bus operator and customer safety to reduced legal expenses. And as with most large projects that encompass entire agencies, the systems require a champion to implement them successfully.

Accomplishing these goals, though, did not happen overnight. It was necessary to pre-test and test equipment; install equipment; develop maintenance, labor relations, and legal policies and procedures to operate and maintain the cameras; and dedicate staff to maintain and review the videos collected. Agencies documented the importance of specifying the equipment properly and keeping up with the latest technology.

Given the obvious need for security after 9/11, security grants help fund the surveillance programs. However, the benefits have gone beyond security and security is no longer necessarily the primary reason for camera installation. At SEPTA in Philadelphia, the legal department took responsibility for security and launched the centralized program because of the concomitant high number and value of legal claims agencywide. Philadelphia's surveillance technology is paying for itself, as it has decreased claims payouts by tens of millions.

No department can implement and develop a successful camera system by itself. All of the agencies had and required support from executive management to be successful. Various departments, including bus operations, security, and legal launched the electronic surveillance programs at the transit agencies, and they had to work collectively with other departments to be successful. As it is not possible or reasonable to watch all video, the bus operators trigger when an incident occurs so that it can be reviewed and the agencies have various departments such as security, bus operations, and legal view the video for investigative purposes.

TriMet's program in Oregon was launched as a result of public outcry. Years ago, TriMet was reluctant to monitor bus operators with cameras. They were installed after a bus operator was videotaped by someone's personal cell phone reading while driving. This program has had a great impact on labor relations, as TriMet is currently facing arbitration to settle whether an operator may be monitored while he or she is not driving.

Labor relations has a role at all the agencies. Focusing the cameras on the bus operators has both benefits and drawbacks for the bus operators and their union representatives. Although agencies place the cameras in the buses to ensure operator safety from physical assaults, union representatives are concerned about the abuse of using the videos to treat operators unfairly, resulting in discipline. Union representatives are also concerned about the added stress that comes from constantly being monitored while working. In practice, agencies have dealt with this issue by enacting policies that do not allow management to discipline operators based on the videos or allow management to "mine" the videos for discipline purposes.

In some cases, cameras came first and other technology integration happened later, and vice versa. At New York City Transit (NYCT), the bus department is launching the surveillance program by taking advantage of the wireless servers that already exist at the bus depots and monitor the vitals

of the buses. At MBTA in Boston, cameras were installed under the guidance of the security department and monitoring of bus vitals technology was added later.

Development of preventive maintenance practices is necessary, but the information gathered did not identify how this was accomplished. Although the systems primarily self-diagnose, it is not clear if the cameras are among the parts that are checked along with the other vitals of the bus.

The synthesis was not able to make conclusions about the actual costs of installing cameras and systems in agencies. The costs were not broken down to separate hardware items. It would appear logical that systems that were part of bus builds would cost less than retrofits; however, there were insufficient data to establish that. Further research would be needed to identify the actual costs associated with installation.

Technology is difficult to manage, as it changes so fast. Managing technology requires dedicated staff and constant review and updates as equipment becomes obsolete. It can also be expensive. To combat the cost, agencies are evaluating their return on investment (ROI), seeking security grants at the federal and state levels, and buying nonproprietary open systems.

Finally, there is a strong trend toward installing more cameras on buses and this is becoming a standard practice throughout the industry. Surveillance systems are a tool used for many purposes throughout the country and throughout the agencies across many departments.

Opportunities for future research related to this synthesis include

- Identification of costs for installation (e.g., new bus versus retrofit)
- Funding sources for new technology
- Most effective practices of automatic vehicle maintenance systems on buses (e.g., automatic checking of bus vitals)
- Camera specification recommendations for bus fleets
- Incorporation of new technologies into bus maintenance practices
- Onboard electronic surveillance technologies on rail fleets.

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APPENDIX A

Survey Responses

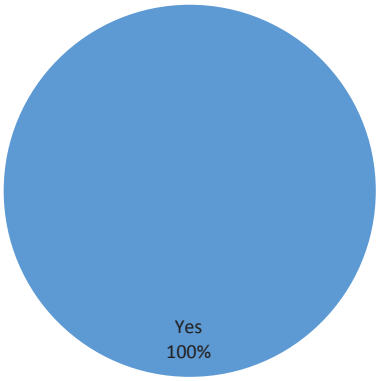
TCRP Project J-7 Synthesis Topic SA-36 Survey

Questions with personal information are deleted from this text.

7. What is the size of your agency's bus fleet?

Response
1,053
1,525
1,100
115
1,150
1,355
16
168 buses and vans
18
±1,870
2,190 buses
2,500
260
278
312
341
410
449
480
488
500
535
549
5,718
624
64 fixed-route buses
70
700
744
797
85
About 630

8. Does your agency currently use or plan to use electronic surveillance on buses? Yes/No



Value	Percent
Yes	100.0%
Total	32

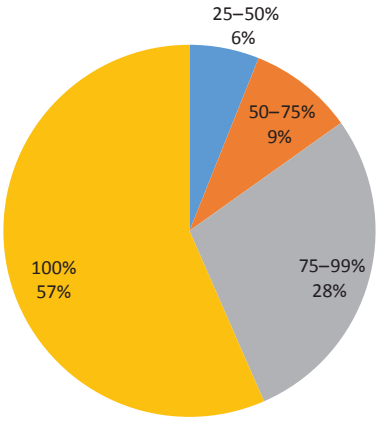
If your agency does not have electronic surveillance cameras, why not?

	Very Significant	Significant	Somewhat Significant	Not Significant
Cost	0.0%	0.0%	0.0%	0.0%
Executive Management	0.0%	0.0%	0.0%	0.0%
Line Management	0.0%	0.0%	0.0%	0.0%
Lack of Public Support	0.0%	0.0%	0.0%	0.0%
Unreliable Technology	0.0%	0.0%	0.0%	0.0%
Other Priorities	0.0%	0.0%	0.0%	0.0%
Lack of Union Support	0.0%	0.0%	0.0%	0.0%
Lack of Police Support	0.0%	0.0%	0.0%	0.0%
Other	0.0%	0.0%	0.0%	0.0%

9. When did your agency start using electronic surveillance on buses? Year _____

Response
1990
1990s
1991
1992
1995
1996
1998
2000
2001
2003
2005
2007–2008
2008
2009
2010
2011
2012
2013
Circa 2008
Early 1990s
July 2014
N/A
Not sure
Before 2005
Unknown; prior to 2000

10. What percentage of your fleet is equipped with surveillance equipment?



Value	Percent
25%–50%	6.3%
50%–75%	9.4%
75%–99%	28.1%
100%	56.3%
Total	32

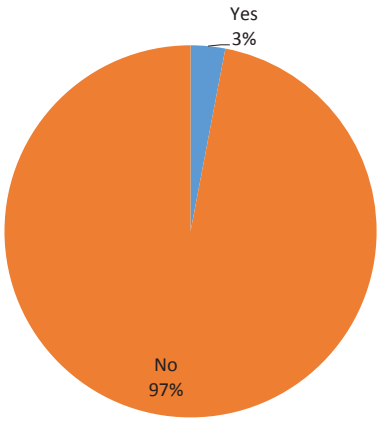
11. Number of buses? Buses purchased with surveillance equipment

Response
684
0
100
115
116
1,175
119
12
146
15
165
180
23
24
2,500
294
400
480
50%
551
64
750
All current purchases
Possibly only recently purchased articulated buses

11. Number of buses? Buses retrofitted with surveillance equipment

Response
0
130
1,612
18
22
220
300
340
350
371
4
410
50%
535
605
624
65
70
8
All of them
Most
N/A

12. Is surveillance equipment limited to particular types of buses?



Value	Percent
Yes	3.1%
No	96.9%
Total	32

30

13. If yes, which types of buses?

Response	
Gillig	

14. If limited to types of buses, why?

	Very Important	Important	Somewhat Important	Not Important
Age of Bus	100.0%	0.0%	0.0%	0.0%
Type of Bus	100.0%	0.0%	0.0%	0.0%
Particular Routes	0.0%	0.0%	0.0%	100.0%
Financial Constraints	0.0%	0.0%	0.0%	100.0%
Other	0.0%	0.0%	0.0%	100.0%

15. What are/were the agency's drivers for using electronic surveillance? Check significance for each.

	Very Significant	Significant	Somewhat Significant	Not Significant	Total
Customer Safety	65.6%	25.0%	9.4%	0.0%	100%
Accidents/Insurance Claims	78.1%	18.8%	0.0%	3.1%	100%
Bus Operator Safety/ Protection	75.0%	21.9%	3.1%	0.0%	100%
Bus Operator Training	12.5%	31.3%	37.5%	18.8%	100%
Bus Operator Performance	15.6%	34.4%	28.1%	21.9%	100%
Deter Criminal Activity (vandalism/graffiti)	65.6%	21.9%	6.3%	6.3%	100%
Fare Evasion	6.3%	34.4%	37.5%	21.9%	100%
Bus Operators Workers Comp	15.6%	18.8%	46.9%	18.8%	100%
Passenger Counting	0.0%	3.1%	21.9%	75.0%	100%
Part of an Agencywide Plan	28.1%	25.0%	31.3%	15.6%	100%
Security Strategy	43.8%	37.5%	12.5%	6.3%	100%
Part of a Citywide Security Strategy	3.1%	12.5%	25.0%	59.4%	100%
Technology Availability	18.8%	28.1%	28.1%	25.0%	100%
Other	9.4%	3.1%	9.4%	78.1%	100%
I Like It	0.0%	0.0%	0.0%	0.0%	100%

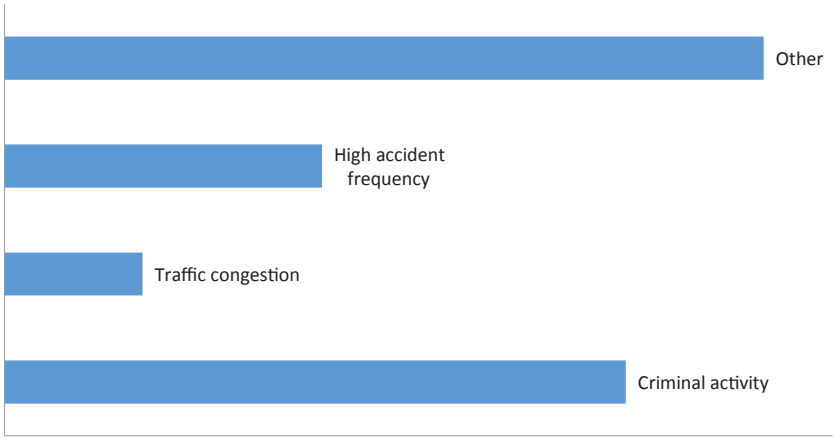
16. Agency benefits for using electronic surveillance?

	Very Significant	Significant	Somewhat Significant	Not Significant
Customer Safety	65.6%	28.1%	6.3%	0.0%
Accidents/Insurance Claims	84.4%	15.6%	0.0%	0.0%
Bus Operator Safety/ Protection	65.6%	34.4%	0.0%	0.0%
Bus Operator Training	28.1%	25.0%	31.3%	15.6%
Bus Operator Performance	25.0%	43.8%	12.5%	18.8%
Deter Criminal Activity (vandalism/graffiti)	50.0%	28.1%	15.6%	6.3%
Fare Evasion	3.1%	21.9%	50.0%	25.0%
Bus Operators Workers Comp	31.3%	21.9%	31.3%	15.6%
Passenger Counting	3.1%	9.4%	15.6%	71.9%
Part of an Agencywide Plan	28.1%	28.1%	28.1%	15.6%
Security Strategy	43.8%	25.0%	15.6%	15.6%
Part of a Citywide Security Strategy	6.3%	12.5%	28.1%	53.1%
Technology Availability	21.9%	18.8%	34.4%	25.0%
Other	6.3%	3.1%	9.4%	81.3%

17. Barriers to implementation?

	Very Significant	Significant	Somewhat Significant	Not Significant
Cost	21.9%	46.9%	18.8%	12.5%
Executive Management	3.1%	3.1%	12.5%	81.3%
Line Management	0.0%	3.1%	15.6%	81.3%
Lack of Public Support	3.1%	3.1%	25.0%	68.8%
Unreliable Technology	0.0%	12.5%	40.6%	46.9%
Other Priorities	0.0%	25.0%	12.5%	62.5%
Lack of Union Support	6.3%	31.3%	12.5%	50.0%
Lack of Police Support	0.0%	3.1%	3.1%	93.8%
Other	0.0%	0.0%	6.3%	93.8%

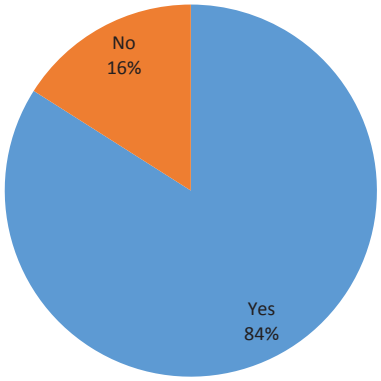
18. If particular routes are chosen for buses, what is the reason?



32

Value	Percent
Criminal activity	45.2%
Traffic congestion	9.7%
High accident frequency	22.6%
Other	54.8%
Total	31

19. Is there a plan to equip all buses with cameras over time?

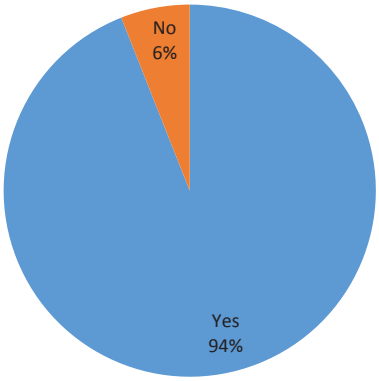


Value	Percent
Yes	84.4%
No	15.6%
Total	32

20. If there is a plan, when will all buses be equipped with electronic

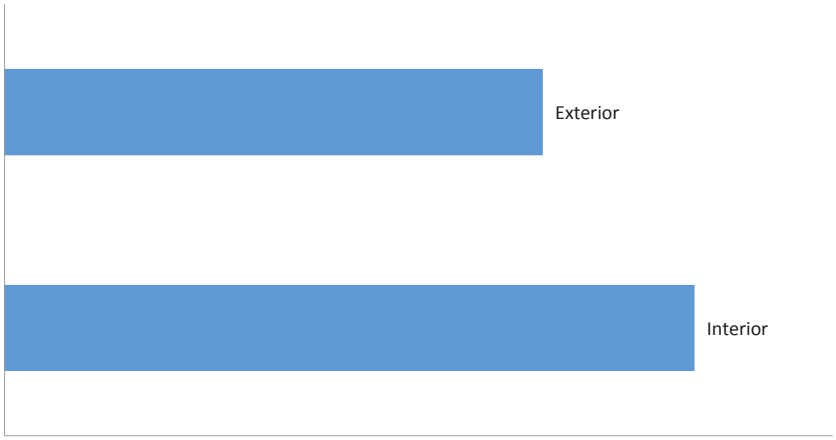
Response
2011
2014
2015
2016
2018
2019
2020
All buses already equipped
All buses are equipped.
All done
Already are
Already done
Currently, 100% of fleets are equipped.
N/A
They all have cameras now.
All are currently equipped.
Fully equipped for 10 years
It is ongoing; as buses are added, they are equipped.
Currently, only 60 coaches do not have electronic surveillance and they will be retired within the next calendar year; all new coaches are speced with systems.

21. Are there signs visible to the customers on the buses stating there is electronic surveillance equipment on the bus?



Value	Percent
Yes	93.8%
No	6.3%
Total	32

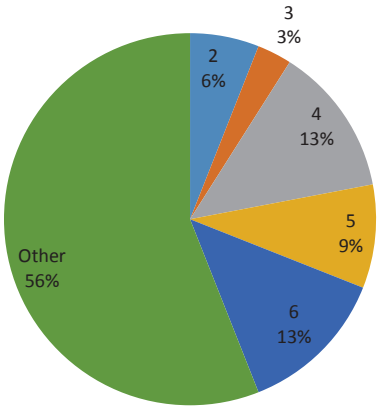
22. Where is your electronic surveillance equipment (or planned to be) located on the bus?



Value	Percent
Interior	100.0%
Exterior	78.1%
Total	32

34

23. On the 1-door bus (i.e., coach or over-the-road bus), how many interior cameras? Check one answer.



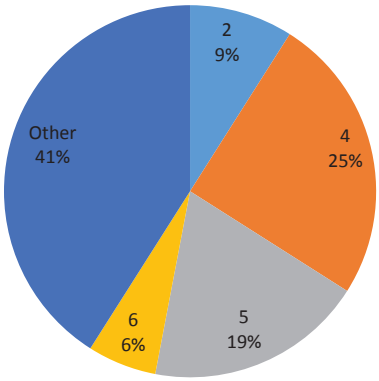
Value	Percent
2	6.3%
3	3.1%
4	12.5%
5	9.4%
6	12.5%
Other	56.3%

Statistics

Sum	62.0
Average	4.4
StdDev	1.3
Max	6.0

Responses "Other"
Left blank
5
7
All buses have 2 doors.
N/A
N/A
No 1-door buses
Safety sensitive
Have none
N/A
We have no one-door coaches.

24. On the 2-door bus, how many interior cameras? Check one answer.



Value	Percent
2	9.4%
4	25.0%
5	18.8%
6	6.3%
Other	40.6%
Total	32

Statistics

Sum	80.0
Average	4.2
StdDev	1.2
Max	6.0

Responses "Other"
Left blank
12
7
8
9
N/A
N/A
Between 5 and 7
N/A
We have a mix; some have a few as four, others six.

25. On the 1-door bus (i.e., coach or over-the-road bus), what are the interior camera views?

	Yes	No
From Operator's View Forward	51.6%	48.4%
Farebox and Front Door	48.4%	51.6%
Rear Door	35.5%	64.5%
From Panel Behind Operator Facing Rear	48.4%	51.6%
From Rear of Bus Facing Forward	35.5%	64.5%
Focused on the Operator	16.1%	83.9%
Other	29.0%	71.0%

26. If other views on the 1-door bus interior, please describe. If not applicable, "N/A."

Response
N/A
360-degree view interior
Exterior cameras and forward-looking camera
Front door to as much of the rear benches as possible
Front of bus facing back down aisle
Lift and designated seating area
N/A
N/A
We don't have single-door buses.
N/A
No 1-door buses

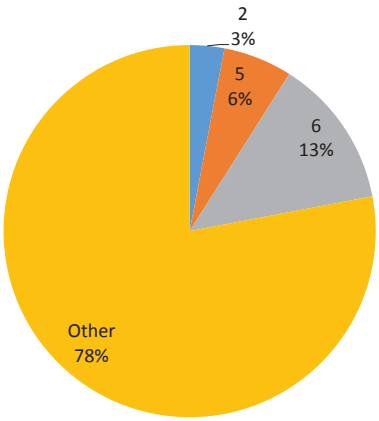
27. On the 2-door bus, what are the interior camera views?

	Yes	No
From Operator's View Forward	84.4%	15.6%
Farebox and Front Door	93.8%	6.3%
Rear Door	90.6%	9.4%
From Panel Behind Operator Facing Rear	87.5%	12.5%
From Rear of Bus Facing Forward	62.5%	37.5%
Focused on the Operator	28.1%	71.9%
Other	46.9%	53.1%

28. On the 2-door bus, please describe other interior views. If not applicable, "N/A."

Response
360-degree view of buses
Above the door in the exterior of the bus
As indicated above
Exterior cameras and forward-looking camera
From the midbus location facing rear
Front door to as much of the rear benches as possible
Front of bus facing back down aisle
Inside middle facing rear
Midbus facing to rear
Midbus interior
Midpoint to the rear
N/A
N/A
Rear deck from center of coach
Rear door facing rear
Rear of the bus to back passenger seats
View forward facing modesty panel behind operator, wheelchair areas
N/A
Rear mezzanine deck, near rear door, facing rear forward facing from behind operator viewing standee line area, seatbelt, profile of those entering bus

29. On the 3-door bus, how many interior cameras? Check one answer.



Value	Percent
2	3.1%
5	6.3%
6	12.5%
Other	78.1%
Total	32

38

Statistics

Sum	36.0
Average	5.1
StdDev	1.4
Max	6.0

Responses "Other"
Left blank
10
11
7
8
9
N/A
N/A
N/A
No 3-door buses
N/A
N/A
No 3-door buses

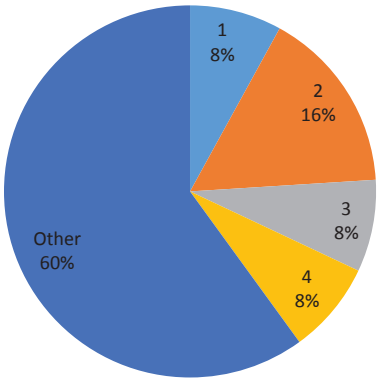
30. On the 3-door bus, what are the interior camera views?

	Yes	**No**
From Operator's View Forward	43.8%	56.3%
Farebox and Front Door	46.9%	53.1%
Rear Doors	46.9%	53.1%
Midpoint of Bus	46.9%	53.1%
From Panel Behind Operator Facing Rear	46.9%	53.1%
From Rear of Bus Facing Forward	38.7%	61.3%
Focused on the Operator	16.1%	83.9%
Other	25.0%	75.0%

31. If other interior views on the 3-door bus, please describe.

Response
3rd door, additional midpoint for both directions
Exterior cameras and forward-looking camera
Front of bus facing back down aisle
Midpoint facing rear
N/A
N/A
Midpoint facing forward
N/A
No 3-door buses
Rear deck

32. On 1-door buses, how many exterior cameras? Check one answer.



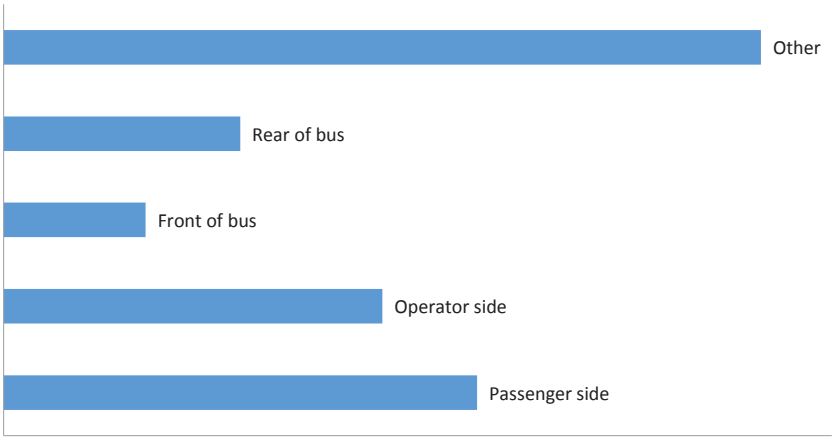
Value	Percent
1	8.0%
2	16.0%
3	8.0%
4	8.0%
Other	60.0%
Total	25

Statistics

Sum	24.0
Average	2.4
StdDev	1.0
Max	4.0

Responses "Other"
Left blank
N/A
N/A
None
N/A
No 1-door buses
No one-door coaches
None

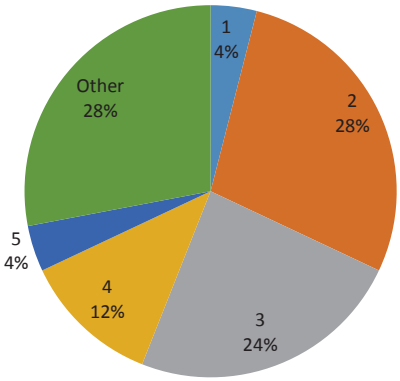
33. On 1-door buses, where are the exterior cameras located?



Value	Percent
Passenger side	40.0%
Operator side	32.0%
Front of bus	12.0%
Rear of bus	20.0%
Other	64.0%
Total	25

Responses "Other"
Left blank
N/A
N/A
None
Operator front and passenger rear
N/A
No 1-door buses
No one-door coaches

34. On 2-door buses, how many exterior cameras? Check one answer.



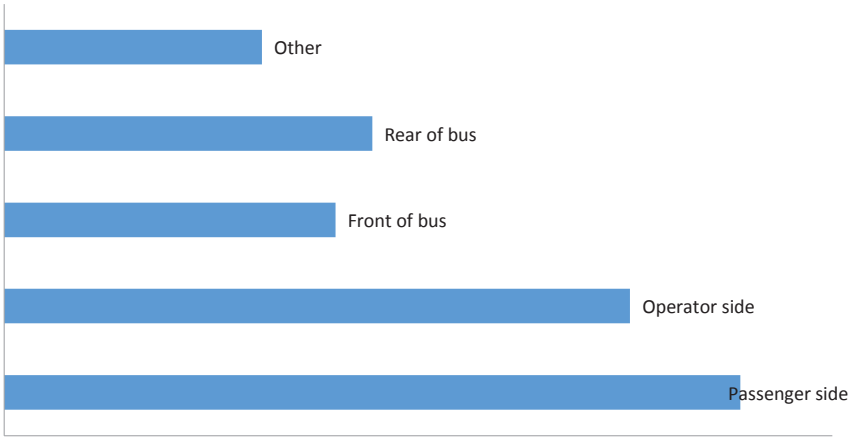
Value	Percent
1	4.0%
2	28.0%
3	24.0%
4	12.0%
5	4.0%
Other	28.0%
Total	25

Statistics

Sum	50.0
Average	2.8
StdDev	1.0
Max	5.0

Responses "Other"
Left blank
N/A
N/A
None
Operator front and passenger rear
From one to three
Up to 2 depending on build date
Zero exterior cameras

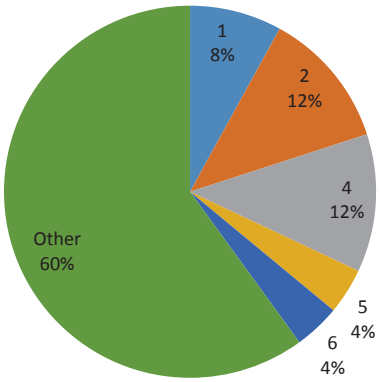
35. On 2-door buses, where are the exterior cameras located?



Value	Percent
Passenger side	80.0%
Operator side	68.0%
Front of bus	36.0%
Rear of bus	40.0%
Other	28.0%
Total	25

Responses "Other"
Left blank
N/A
N/A
None currently (2 planned)
Operator front and passenger rear
Rear door
Some only have passenger side and forward facing

36. On 3-door buses, how many exterior cameras? Check one answer.



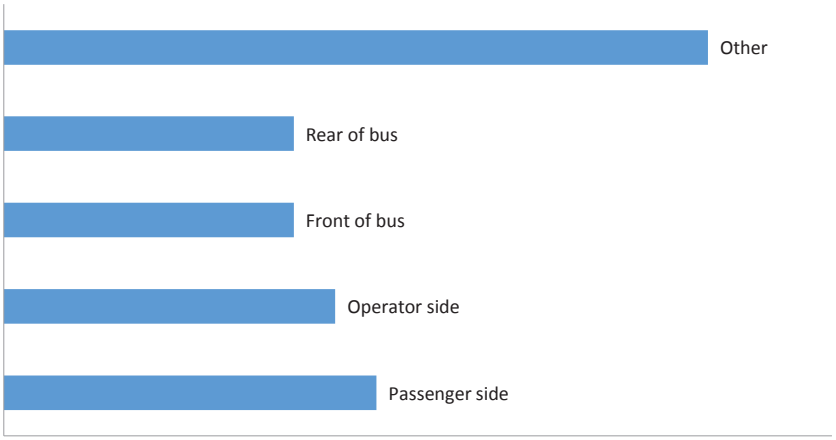
Value	Percent
1	8.0%
2	12.0%
4	12.0%
5	4.0%
6	4.0%
Other	60.0%
Total	25

Statistics

Sum	31.0
Average	3.1
StdDev	1.6
Max	6.0

Responses "Other"
Left blank
N/A
N/A
No 3-door buses
None
Operator front and passenger rear
N/A

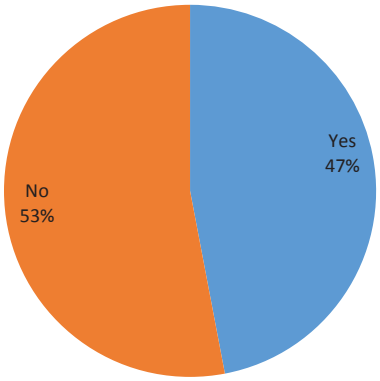
37. On 3-door buses, where are the exterior cameras located?



Value	Percent
Passenger side	36.0%
Operator side	32.0%
Front of bus	28.0%
Rear of bus	28.0%
Other	68.0%
Total	25

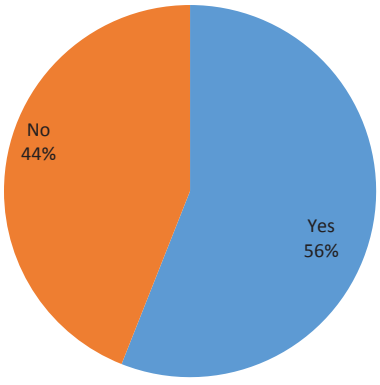
Responses "Other"
Left blank
Front located inside
N/A
N/A
None
Operator front and passenger rear
Rear end of each side of bus
N/A
No 3-door buses

38. Is there surveillance of the bus operator while he/she is driving the bus?



Value	Percent
Yes	46.9%
No	53.1%
Total	32

39. Is there a policy allowing/disallowing surveillance of bus operator?

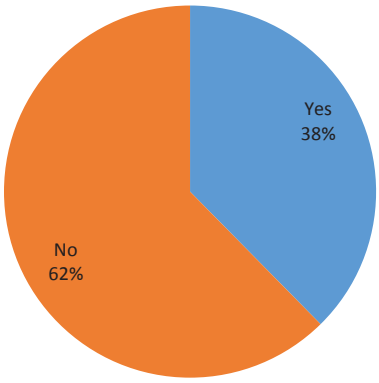


Value	Percent
Yes	56.3%
No	43.8%
Total	32

40. What is your agency's policy allowing/disallowing electronic surveillance of bus operators?

Response
4.1.07 Audio Video Security Policy 4.1.07-1 SOP Bus Cameras
Agreement with union
Camera is not activated until EA button is pressed by driver.
Currently in arbitration with operator's union to utilize the camera positioned on the operator.
It is part of the Bargaining Contract—Union fears management will "mine" video for discipline.
N/A
N/A
Only glancing views of the operator is allowed.
Policy states agency will not monitor the driver.
The union contract does not allow surveillance on the transit operator.
We cannot directly record the operator.
Not allowed
Understanding with local operators union
Agreement with the union, which was subsequently disputed by the union attempting to disallow audio and prevent disciplinary action from video
Our agreement with the union does not prevent us from having electronic surveillance of the bus operator.
There must be a reported customer service issue, an accident, or police or public request to view the video. Cannot randomly view video.
No predatory fishing of video. We have a neutral party retrieving video for all major stakeholders.
It is not done; position of camera with operator's position in field of view only shows right arm or shoulder.

41. Is there a policy allowing/disallowing surveillance equipment on buses?

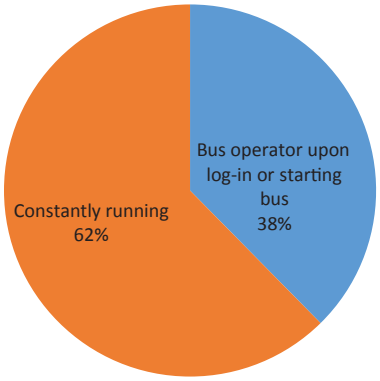


Value	Percent
Yes	37.5%
No	62.5%
Total	32

42. If your agency has an electronic surveillance policy for buses, what is it?

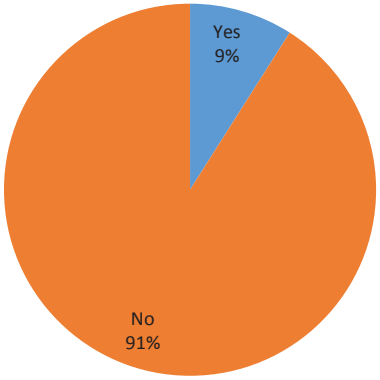
Response
4.1.07 Audio Video Security Policy 4.1.07-1 SOP Bus Cameras
Allowed and how it is allowed
For the safety of the passengers and operator
Interior notices that cameras are in place and used must be posted in both English and Spanish.
N/A
N/A
Same
They are required.
Don't have access to the text
"For security, safety, and supervisory purposes, the employer reserves the right to install and operate video and audio recording systems in all Valley Transit vehicles and facilities. Audio records shall not be used for the purpose of Valley Transit disciplinary action unless related to the commission of an illegal act by the employee."
For use in investigation into security or criminal investigations, incidents involving vehicle accidents, and/or potential for claims of injury or damage to property

43. Who activates the surveillance?



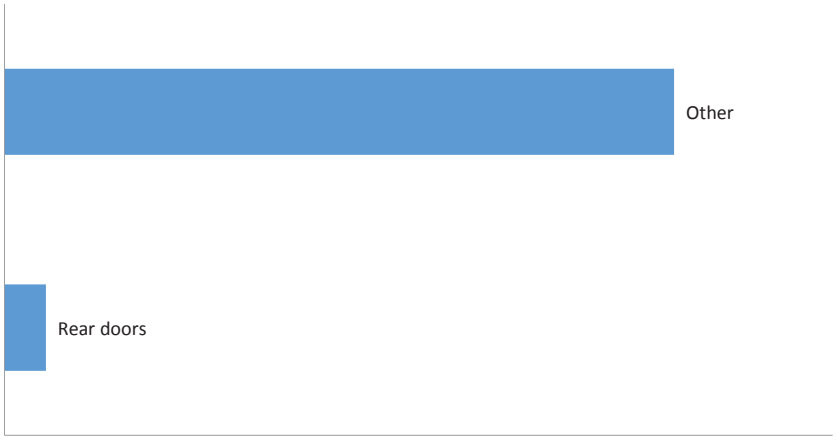
Value	Percent
Bus operator upon log-in or starting bus	37.5%
Constantly running	62.5%
Total	32

44. Does driver have access to camera views while driving?



Value	Percent
Yes	9.4%
No	90.6%
Total	32

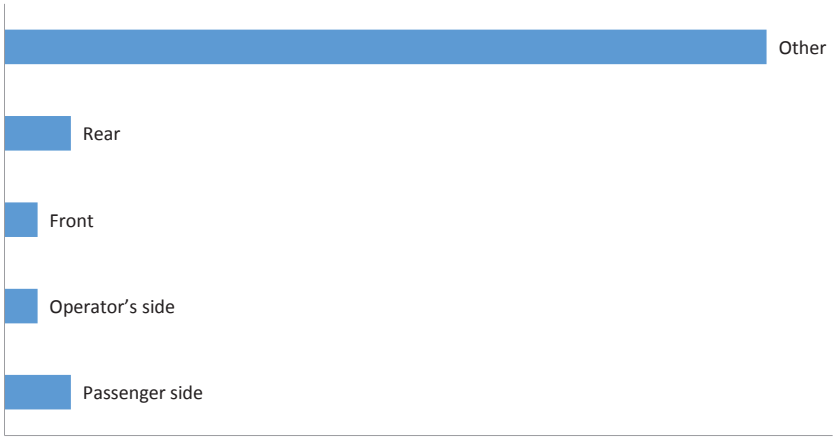
45. If driver has access to camera views while operating the bus, where can he/she see? Interior location(s)



Value	Percent
Rear doors	6.5%
Other	96.8%
Total	31

Responses "Other"
Left blank
Cannot view
Does not have access
N/A
N/A
No access
See Question 40
Some buses show rear door view.
They can't—don't
N/A
N/A
No access
Rear doors on some coaches only when they are opened at a stop; view on dash multifunction display

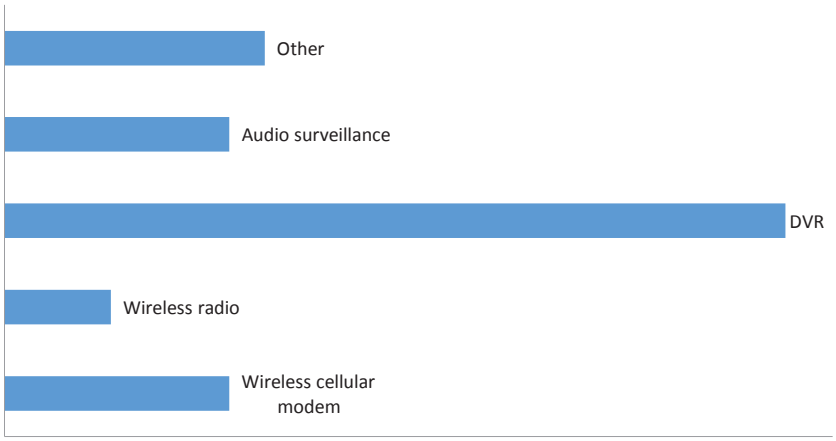
46. If driver has access to camera views while operating the bus, where can he/she see? Exterior location(s)



Value	Percent
Passenger side	8.0%
Operator's side	4.0%
Front	4.0%
Rear	8.0%
Other	92.0%
Total	25

Responses "Other"
Left blank
Don't
Does not have access
N/A
N/A
No access
See Question 40
Some buses have an exterior backup camera
N/A
N/A
No access

47. What type of equipment do you have or plan to have on your buses?



Value	Percent
Wireless cellular modem	18.8%
Wireless radio	9.4%
DVR	65.6%
Audio surveillance	18.8%
Other	21.9%
Total	32

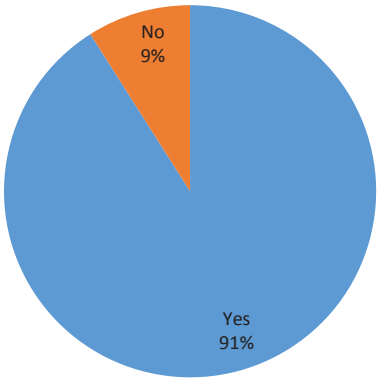
Statistics

Sum	134.0
Average	4.2
StdDev	1.2
Max	5.0

Responses "Other"
Left blank
All of above
DVR and audio. May explore modem.
DVR Wcm capable
GPS
Named system
Wi-Fi
Currently have DVR. We are in the process of hiring a company to place wireless cellular modems in buses to allow live monitoring. Our newer buses purchased beginning in 2012 have audio surveillance but use of the audio is currently in arbitration with the operators' union.

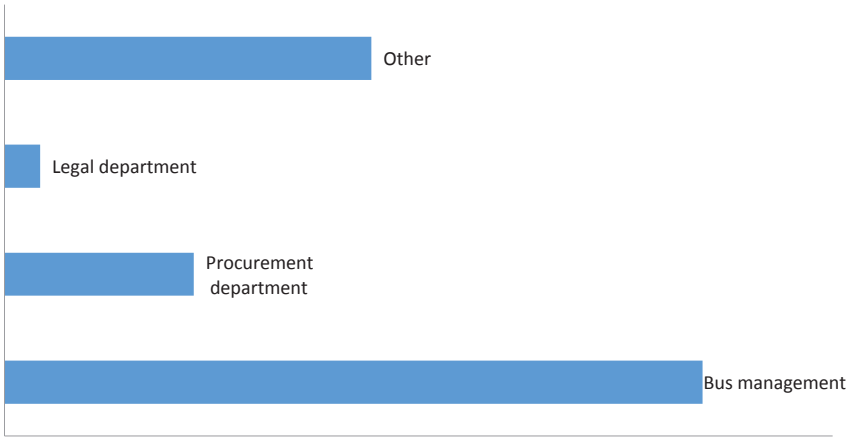
50

48. Do your new bus purchases include electronic surveillance equipment?



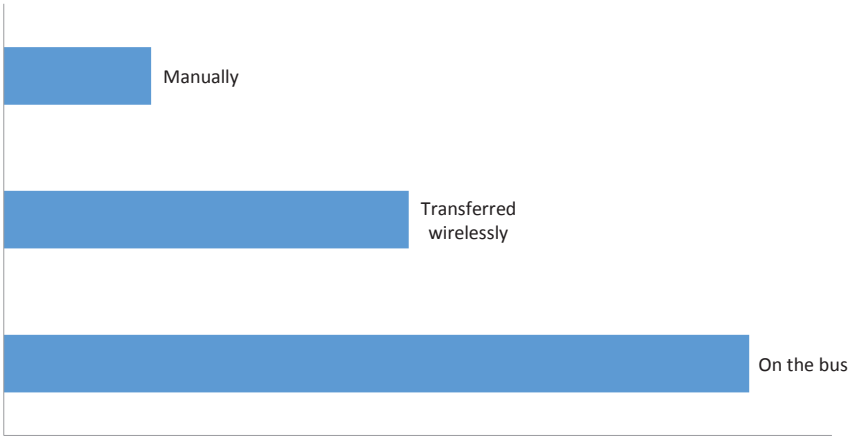
Value	Percent
Yes	90.6%
No	9.4%
Total	32

49. Who determines what kind of equipment is used?



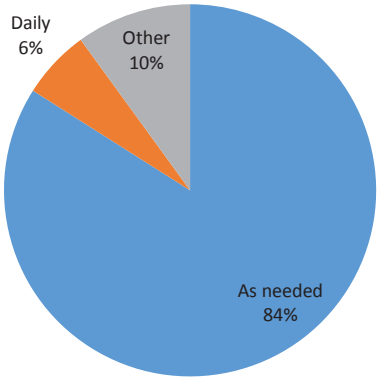
Value	Percent
Bus management	59.4%
Procurement department	15.6%
Legal department	3.1%
Other	31.3%
Total	32

50. How are images stored?



Value	Percent
On the bus	81.3%
Transferred wirelessly	43.8%
Manually	15.6%
Total	32

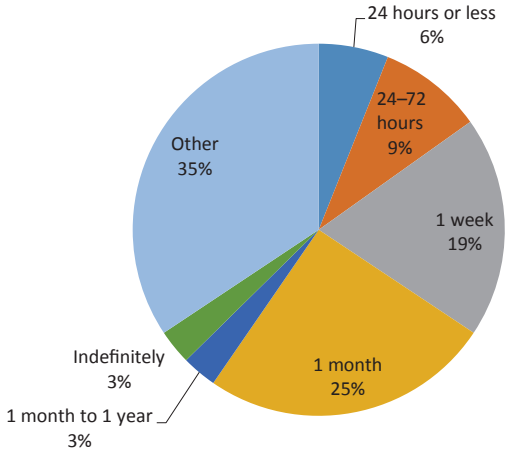
51. If images are downloaded, how often?



Value	Percent
As needed	83.9%
Daily	6.5%
Other	9.7%
Total	31

Responses "Other"
Left blank
Whenever bus ignitions off in a UTA Wi-Fi zone
As needed by law enforcement

52. How long are images stored ON the bus?



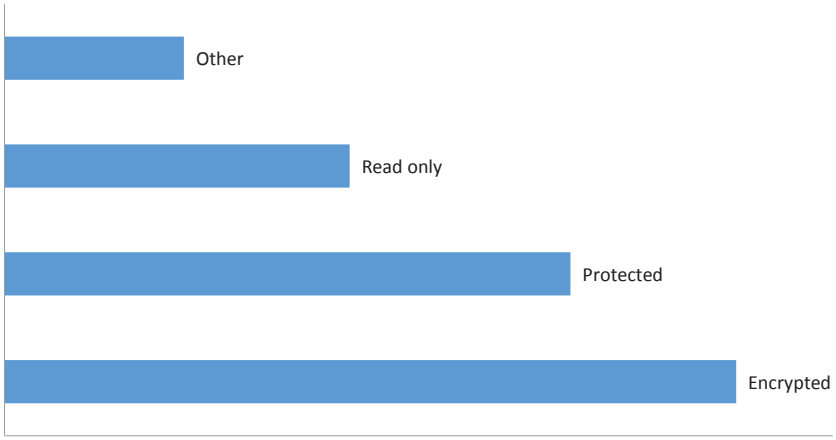
Value	Percent
24 hours or less	6.3%
24–72 hours	9.4%
1 week	18.8%
1 month	25.0%
1 month to 1 year	3.1%
Indefinitely	3.1%
Other	34.4%
Total	32

Statistics

Sum	135.0
Average	6.8
StdDev	10.0
Max	24.0

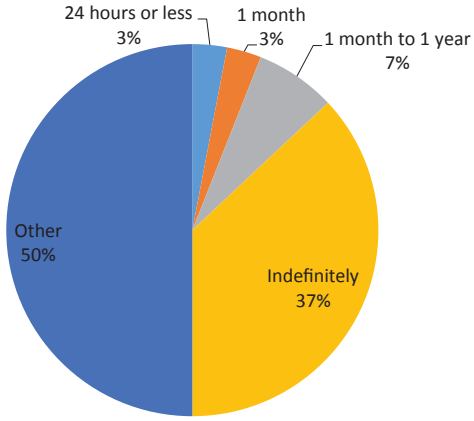
Responses “Other”
Left blank
1–2 weeks possible
14 days
2 weeks
5 days
Depending upon hard drive size
Varies
Varies by bus type, age. Anywhere from 5 days to 2 weeks.
Older generation 7 days, newer generation up to 30 days
Video is first in first out; DVR will record over unless a tag is set.
Older systems—72 hours unless we retrieve the video; newer system—30 days unless we save the video

53. Are the images:



Value	Percent
Encrypted	53.1%
Protected	40.6%
Read only	25.0%
Other	12.5%
Total	32

54. How long are images stored OFF the bus?



Value	Percent
24 hours or less	3.3%
1 month	3.3%
1 month to 1 year	6.7%
Indefinitely	36.7%
Other	50.0%
Total	30

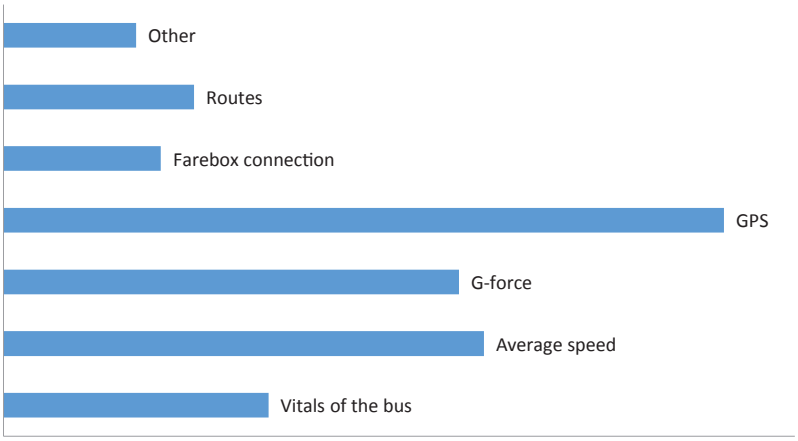
54

Statistics

Sum	27.0
Average	6.8
StdDev	10.0
Max	24.0

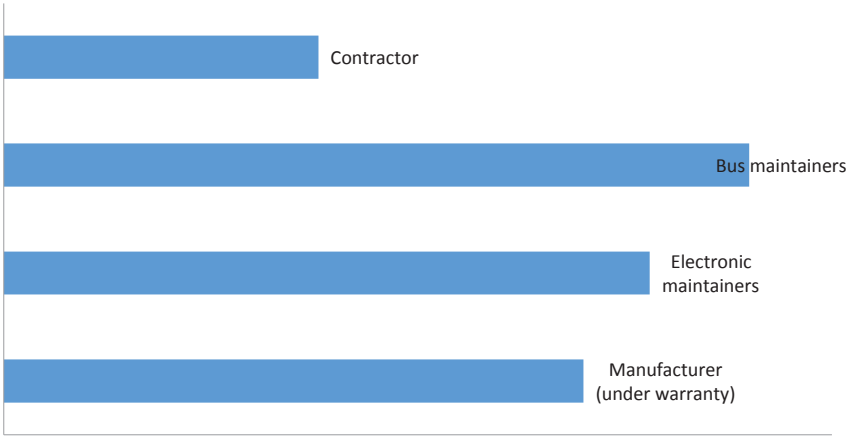
Responses "Other"
Left blank
3 years
3 years or indefinitely for felony
As needed depending on the incident
As needed
Depends on whether there is a case pending
Incidents are retained through settlement.
Indefinitely if related to an accident or incident
N/A
Ten years
Two years
Varies
Legal requirements vary
Until no longer needed

55. What technical integrations does the equipment currently or plan to have?



Value	**Percent**
Vitals of the bus	32.3%
Average speed	58.1%
G-force	54.8%
GPS	87.1%
Farebox connection	19.4%
Routes	22.6%
Other	16.1%
Total	31

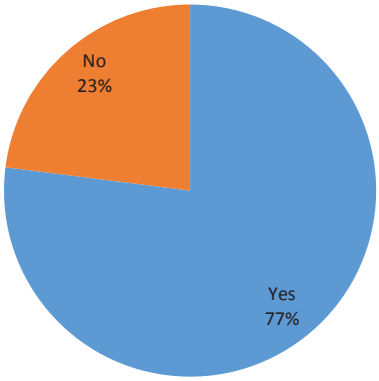
56. Who maintains equipment on the bus?



Value	Percent
Manufacturer (under warranty)	35.5%
Electronic maintainers	38.7%
Bus maintainers	45.2%
Contractor	19.4%
Total	31

Responses "Other"
Left blank

57. Does system self-diagnose?

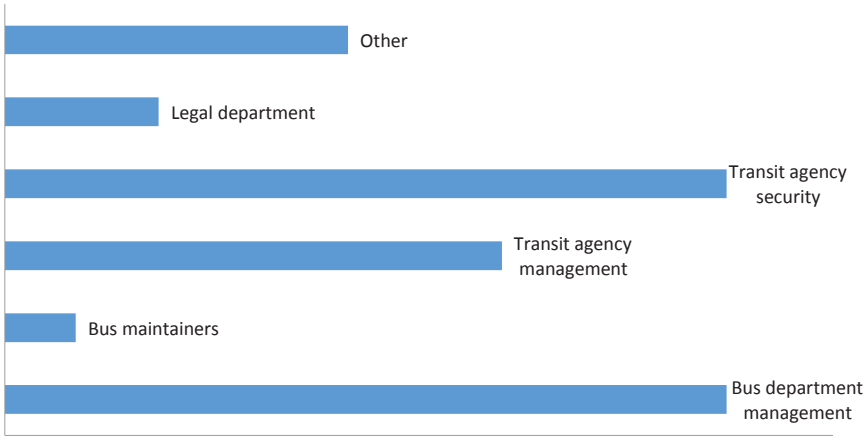


Value	Percent
Yes	77.4%
No	22.6%
Total	31

58. If so, how often?

Response
24/7
Camera check, DVR status, available storage
Constant health monitor, stores and reports data upon depot entry
Constantly
Continuous
Daily
Daily, upon start-up
Every day
Every time the bus checks in the depot, which is daily
Not sure
Poles every 15 minutes
Upon arrival at the garage electronically
When rebooted
When required
Continuously
Daily
Daily reports generated by system
Every few minutes
Live
Once a day
Each time the bus is started, but operators do not have access to the current status and it is not currently "reporting" wirelessly. So ... failure is found out after the fact.

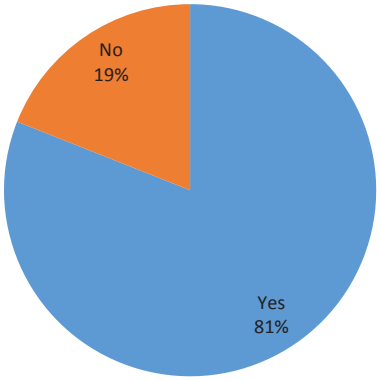
59. Who has direct access to the stored information?



Value	Percent
Bus department management	61.3%
Bus maintainers	6.5%
Transit agency management	41.9%
Transit agency security	61.3%
Legal department	12.9%
Other	29.0%
Total	31

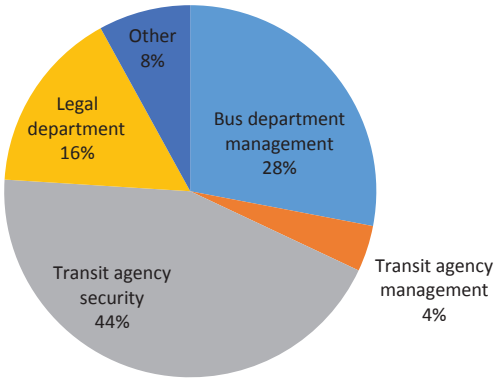
Responses "Other"
Left blank
Internal police department
Safety department
Security
Transit police only
Transit police force
Video security administrator
Chain of custody is the issue.
Claims department

60. Is there a chain of custody associated with the images?



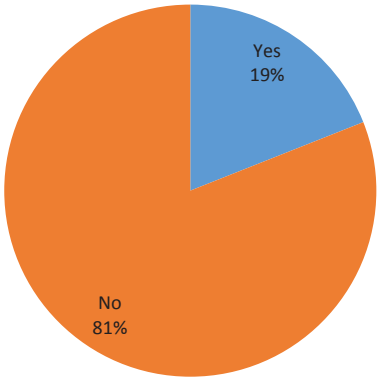
Value	Percent
Yes	80.7%
No	19.4%
Total	31

61. What department is responsible for the chain of custody?



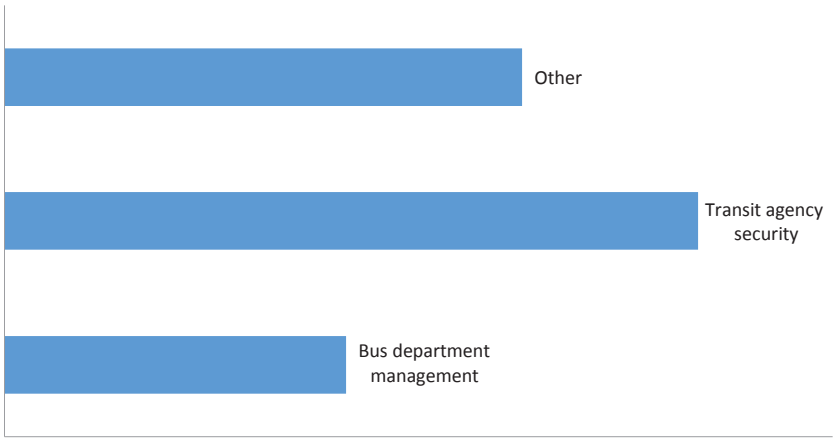
Value	Percent
Bus department management	28.0%
Transit agency management	4.0%
Transit agency security	44.0%
Legal department	16.0%
Other	8.0%
Total	25

62. Can images be viewed in real time?



Value	Percent
Yes	19.4%
No	80.7%
Total	31

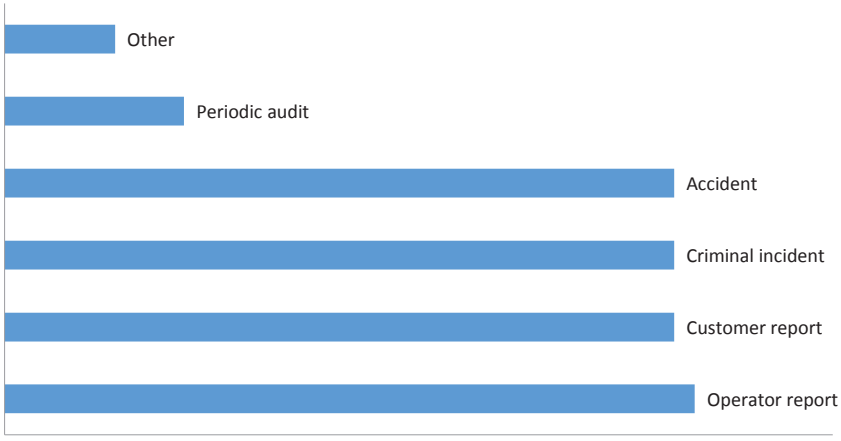
63. If yes, by whom?



Value	Percent
Bus department management	33.3%
Transit agency security	66.7%
Other	50.0%
Total	6

Responses "Other"
Left blank
Internal police department
N/A
Transit police only

64. What triggers review of the images?



Value	Percent
Operator report	100.0%
Customer report	96.8%
Criminal incident	96.8%
Accident	96.8%
Periodic audit	25.8%
Other	16.1%
Total	31

65. If equipment was part of bus purchase, approximately how much did it cost per bus type to implement system? 1 door

Response
$11,000
$15,000
$7,000
$14,000
$4,000
$8,000
Don’t know
N/A
N/A
Not available
Not known by me
N/A
Project not complete, so actual cost is not available at the time.

65. If equipment was part of bus purchase, approximately how much did it cost per bus type to implement system? 2 door

Response
$10,000
$10,674.00
$12,000
$15,000
$5,000
$6,000
$7,000
$9,800
0
$10,000
$10K
$13,000
$15,000
$4,000.00
$5,000
Don’t know
N/A
N/A
Not available
Not known by me
Price not broken out
Don’t know
N/A
Not certain

65. If equipment was part of bus purchase, approximately how much did it cost per bus type to implement system? 3 door

Response
$10,000
$12,168.00
$13,000
$15,000
$12K
$13,000
$16,000
$4,000.00
Don't know
N/A
N/A
Not available
Not known by me
Price not broken out
N/A

66. If equipment was retrofitted, approximately how much did it cost per bus type to implement system? 1 door

Response
$10,000
$12,000
$14,000
$4, 000.00
$4,000
N/A
N/A
Not available
Not known by me
N/A
No one-door coaches

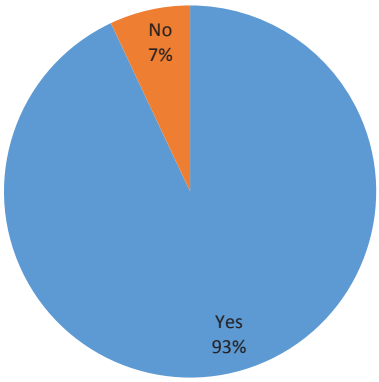
66. If equipment was retrofitted, approximately how much did it cost per bus type to implement system? 2 door

Response
$10,000
$13,000
$15,000
$2,700/bus in 2006
$5,000
$7,600
$15,000
$17,387
$4,000.00
$4,000–$6,000
$5,500
$5K
$6,810
$8,000
N/A
N/A
Not available
Not known by me
N/A
No retrofits

66. If equipment was retrofitted, approximately how much did it cost per bus type to implement system? 3 door

Response
$10,000
$14,000
$16,000
$17,765
$4,000.00
N/A
N/A
Not available
Not known by me
N/A
No retrofits

67. Have there been financial benefits associated with surveillance equipment?



Value	Percent
Yes	93.3%
No	6.7%
Total	30

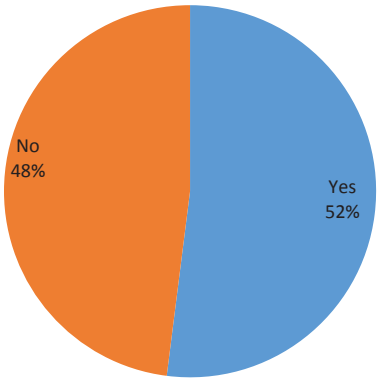
68. If so, what financial benefits? If no financial benefits, "N/A."

Response
Cameras have disproved claims against the transit district.
Claims and accident investigations
Decrease in false claims
Financial savings have not been documented.
Have been a great assistance when investigating claims of onboard injury
Improved operator behavior; reduction in severity
In case of an accident, who was at fault. Incident, what happen is case of legal action.
It exposes fraudulent claims made by riders, and it also deters people from making false claims.
Less claims
Liability claims reduction
Lower claim costs
More claims proved to be not the fault of the bus company
Proof of liability or no liability in claims or accidents, arrests of vandals, etc.
Reduced claims, reduced worker's compensation
Reducing insurance claims
Reduction in contract price
Reduction in tort claim payouts
Risk management claims are refuted with video evidence.
Saved losses from potential rider injury/accident claims
Significant impact to claims/litigation payout
Some possible benefits from false claims of being hurt on the bus
The camera systems have helped NYCT in lawsuit litigation.
Video has stopped some big lawsuits it there tracks.
Claims have been reduced.
N/A
Video evidence of accidents to disprove false accounts. Eliminating grievances by having proof of driver's conduct.
We conduct over 7,000 potential liability claims investigations per year, saving the RTD millions in false or extensive claims. We also use video for restitution after convictions.
Risk management's reduction of false claims. Reduced criminal activity interfering with revenue operations.

69. Is surveillance equipment used for training bus operators?

	Yes	No
Accident Prevention	54.8%	45.2%
Customer Service	51.6%	48.4%
Other	32.3%	67.7%

70. Are union representatives active in developing surveillance policy?



Value	Percent
Yes	51.6%
No	48.4%
Total	31

71. What was your greatest challenge?

Response
Acceptance by operators
Configuration issues
Cost
Cost and employee acceptance
Equipment reliability
Implementation of a maintenance program and system reliability
Inability to have audio recorded
Keeping systems working and reliable
Maintaining support for various systems simultaneously and maintaining a 100% operational goal
Maintaining technology without a budget for it. Some equipment is 14 years old.
N/A
No real challenge; union had some concerns but they have not amounted to anything.
None
Operator buy in
Privacy issues, union issues
Replacing obsolete systems
Technical implementation
The greatest challenge was to prevent videos from skipping.
Trying to get the video placed on the operator
Union allowing video evidence for disciplining purposes
Convincing operators it would help them
Keeping systems monitored and repaired
The cost of the equipment, maintaining it, and upgrading as technological advancements are made are big challenges. Also getting the operators' union to support the use of some of the technology has been difficult. We are currently in arbitration with the union to be able to use the camera directed at the operator's compartment as well as the audio.
Staffing up to handle the volume of incidents triggered for counseling by front line supervision. Union pushback when employees were disciplined for images discovered while operating equipment… (cell phone use, traffic signal violations, etc.).
Inability to discipline for major rule violations observed on video not related to complaint as to why video was viewed. (Exception is cell phone use.)
Keeping systems maintained. It's a big commitment. Also funding for updates and state of good repair.
Every time we copied a video from a vehicle surveillance tape our whole network would slow down.
To get buy-in from the work group that in most cases the onboard video would vindicate their actions.
Implementing procedures and IT capabilities for downloading, reviewing, saving, and sharing videos

72. How did you overcome it?

Response
Federal funds
Awarded a contract to maintain CCTV
Cannot overcome it. State law prohibits audio recording in surveillance systems.
Constant feedback to senior leadership
Continued planning committee, executive support, grant funding support
Have not completely
Have not overcame it, yet still working on it.
N/A
N/A
Negotiation as to how much video can be admissible
Openness and transparency
Project still not complete
Reduced the public's complaints by having proof of activities
Replace entire systems.
Stick to it.
Still discuss rule violation with employee, but nothing is in the file.
The manufacturer developed a new software.
Through real incidents of bus operators being vindicated when accused of wrongdoing
Training vendor support; better technology
Worked through IT issues and created best practices for accomplishing all of the tasks.
Time and patience
We are always looking to be strategic with our funding. The security the cameras provide for our employees and our riders is vitally important. By the end of the year, all our buses will have cameras. We are currently in arbitration with the operators' union to be able to use the camera directed at the operator's compartment as well as the audio.
Implementing video program, hire systems support contractor, and development of real partnership with DVR manufacturer/ software developer
PERC (public employee relations commission ruling) permitting the use of developing technology being ruled as not a negotiable item for bargaining. Used triggered events to reinforce positive behavior to show benefit of cameras through awards for collision avoidance.
Out MIS department expanded our bandwidth to accommodate the necessary increased usage from the video surveillance being copied to our server.
Transitioned to same system on the entire fleet and by maintaining good relationships with vendors.
Update and mandate a preventive maintenance program, upgrade daily reports and who receives them, constant training of maintenance personnel and transit police force
Satisfied requirements set by Privacy Commission. Came to agreement with union regarding use for discipline, etc.

73. Lessons learned? Please identify.

Response
Cameras are an important, vital tool in the security of employees and riders.
Have a dedicated staff to manage the asset after implementation.
Higher-definition cameras and more of them are definite pluses.
It is better to have too many cameras than the minimum that you can get by with.
Most important to find a video system that is easy to use and reliable
N/A
N/A
N/A
None
Trial equipment for a longer period of time.
Try to get coach operators involved from the beginning.
Try to stay away from having more than one type of video system for all your video.
Would have negotiated more on getting a full view of the operator
N/A
CCTV equipment is sensitive to high temperatures during the summer and needs to be well ventilated to maintain proper operation.
Standardizing the entire fleet to one system as a sole source helps in investigations, maintenance, and upgrades. We also used a Panasonic non-proprietary server that has the capability of changing software vendors at any time.
Not to purchase a network system that is manufactured for just a single customer. The Wi-Max network that is manufactured just for NYCT use with the bus camera system has become end of life.
Set too narrow a window for retention of video, found agreement for non-use for discipline to be flawed (my opinion)
We were early to the video surveillance usage and learned that technology changes very fast, the system has increased in price and function, and making sure that you have a program to upgrade the systems is important.
Upgrade equipment to maintain technology life cycle. Upgrade to improve download abilities. Went from B&W to color. Went to infrared cameras for low light conditions. Better resolution cameras.
1) Important to achieve confidence in system reliability—still working that. 2) DVRs are far more robust than even the provider knows. 3) Transit systems video users group can drive mobile video industry.
Start small when determining which videos to review, as it is time-consuming. Dedicate staff to the process who have time and technical capabilities. Create a public records request process for inevitable requests for video clips. Store video in protected environments and allow limited access to prevent from being shared outside the agency.
Keep all parties engaged in the conversation regarding failures and what is expected; training, training, training.
Be VERY specific as to what you want on the RFP and ensure requirements are adhered to by vendor. MCTS is currently in the process of writing an RFP for an 8-camera system with wireless downloading, accelerometer, and GPS.

74. Recommendations/Comments?

Response
I would like a copy of the survey findings once concluded. Sorry for the delay.
N/A
None
Nothing
Plan on midlife upgrades, improvements
Shop around and set up demo of systems to find the system that fits your needs.
Stay up on the latest technological advancements.
Try to do as many pilots as possible before making a purchasing decision.
N/A
Once law enforcement is aware of the availability of surveillance video, it will be a full-time job to keep up with all internal and external video requests.
Should have a larger window for retention, and video should be allowed to be used in investigation into performance or disciplinary issues (my opinion).
When purchasing a surveillance system, it is best to have a system that sends an alert automatically when an error is recorded. For the network, it is best to purchase a system that is commercially available off the shelf and is compatible with other networks.
Surveillance is valuable for liability purposes, accident investigation, customer service, and training. Although there is a cost, it is well worth the investment. Although there is always some suspicion among bus operators and unions, our experience is that they have accepted that they are a valuable tool, and it is up to management not to abuse the use of the tool or use surveillance as a hammer to catch operators.
Conduct site visits to other properties with the selected vendor to see how all stakeholders view the solution.
Do not leave these decisions to amateurs that consider the lowest bid the best value. These systems are VITAL to a safe and secure operation.

APPENDIX B

List of Participating Transit Agencies

Bi-State Development Agency (St. Louis)

Capital District Transportation Authority (Albany)

Capital Transit

City of Phoenix, Public Transit

CT TRANSIT (Hartford)

Greater Cleveland Regional Transit Authority

Greater Dayton RTA

Intercity Transit (Olympia, WA)

King County—METRO (Seattle, WA)

Lane Transit District (Eugene, OR)

Los Angeles Metro

Massachusetts Bay Transportation Authority

Metropolitan Atlanta Rapid Transit Authority

Milwaukee County Transit System

Nashville MTA

New York City Transit

Niagara Frontier Transportation Authority

NJ Transit

Oahu Transit Services

Port Authority of Allegheny County

Regional Transportation District—Denver

Rhode Island Public Transit Authority

RTC of Southern Nevada

Salem–Keizer Transit

San Diego Metropolitan Transit System

SEPTA

Toronto Transit Commission

TriMet

Utah Transit Authority

Valley Regional Transit (Meridian, ID)

Valley Transit (Walla Walla, WA)

WMATA (Washington, DC)

Abbreviations and acronyms used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TDC	Transit Development Corporation
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation

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ISBN: 978-0-309-27221-6