

# TCRP

## SYNTHESIS 90

TRANSIT  
COOPERATIVE  
RESEARCH  
PROGRAM

### Video Surveillance Uses by Rail Transit Agencies



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**TCRP SYNTHESIS 90**

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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, to adapt appropriate new technologies from other industries, and to 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 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, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of 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 Academy of Sciences, 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 impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended end 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.

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

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**Cover figure:** A Metro Valley Rail train traveling over the Tempe Town Lake Bridge that spans the Tempe, Arizona, Town Lake (*Courtesy: Metro Valley Rail, Phoenix, AZ*).

## 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 purpose of this synthesis was to document the current use of electronic video surveillance technology solely by passenger rail agencies, considering the totality of its use and including onboard railcars, as well as its right-of-way. It was accomplished by means of a literature review, transit agency survey, and case studies. Results describe administrative policies in place surrounding the monitoring of video images either in real time or for post-event analysis, policies surrounding archiving and storing images and employee access to them, other public agencies (primarily police) and the general public, as well as funding sources for installation of new or upgrading of existing video surveillance systems.

Forty-three completed surveys were received from 58 rail transit agencies, a response ratio of 73%. Five case studies across a geographic range of locations (California, Arizona, Texas, Minnesota, and Pennsylvania) offer additional details on a variety of modes, different security configurations (transit police or reliance on local agencies), and systems upgrades to include technologies that other agencies are likely to be considering, including lessons learned.

Dr. Dorothy Moses Schulz and Susan Gilbert, Interactive Elements, New York, N.Y., 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.



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# VIDEO SURVEILLANCE USES BY RAIL TRANSIT AGENCIES

**SUMMARY** Previous TCRP reports, notably *Electronic Surveillance Technologies on Transit Vehicles* (Maier and Malone 2001) and *Transit Security Update* (Nakanishi 2009), have studied overall security and the use of electronic video surveillance technology in the transit environment. *Improving Transit Security* (Needle and Cobb 1997) and *Guidelines for the Effective Use of Uniformed Transit Police and Security Personnel* (Interactive Elements Inc. 1997) considered how transit agencies were using video surveillance as part of their overall security strategies, primarily in conjunction with uniformed patrol by police or security officers. Most of the examples and case studies in earlier reports combined discussions of the use of electronic video surveillance cameras in bus and rail systems and few considered nonsecurity uses of such technology.

This synthesis differs from the earlier ones in several ways. It is the first synthesis to document the current use of electronic video surveillance technology solely by passenger rail agencies and to consider the totality of its use, including onboard railcars and along the right-of-way (ROW). The synthesis also describes current administrative policies on monitoring video images either in real time or for post-event analysis; policies on archiving and storing images and access to them by employees, other public agencies (primarily police), and the general public; and funding sources for installing new or upgrading existing video surveillance systems.

Results of a survey emailed to passenger rail agencies throughout the United States are used to document important issues, including the following:

- The percentage of stations, station platforms, or shelters where surveillance is employed and how decisions are made on which locations to cover.
- The percentage of railcars in which onboard surveillance is employed and how decisions are made on which vehicles to cover.
- Whether video surveillance is employed along the ROW and, if so, where.
- The type of video surveillance systems in use and any special features they may utilize.
- Policies pertaining to monitoring, recording, and archiving images, including chain of custody policies.
- Purposes other than for crime/vandalism prevention for which surveillance is employed and its perceived effectiveness for those applications.
- Whether patrons or employees have been surveyed regarding their perceptions of security and, if so, what those perceptions are.
- Funding sources for installing and/or upgrading electronic video surveillance systems.
- Existing plans for installing video surveillance systems in new vehicles or stations.

Forty-three completed surveys were received from the 58 passenger rail agencies to which questionnaires were sent, a response rate of 73%. Five agencies were selected as case study sites because they reflected a variety of modes, had different security configurations (transit police or reliance on local agencies), and were upgrading their systems to include

technologies that other agencies are likely to be considering. These agencies provided opportunities to share information in a lessons-learned format.

Agencies that did not employ surveillance technology were encouraged to complete the survey by answering two brief questions: (1) whether the agency was considering installing a surveillance system and, if so, where, or (2) whether the agency was not considering installing a surveillance system and, if so, why not. All the responding agencies employed video surveillance in some capacity. Although the authors cannot speak for agencies that did not respond, it is reasonable to say that all passenger rail transit agencies make at least some use of electronic video surveillance on their property.

The following key findings could be determined from completed surveys and case studies:

- The overwhelming majority of passenger rail transit agencies make use of electronic video surveillance somewhere on their property.
- Despite the focus on electronic video surveillance systems in the context of terrorism since September 11, 2001, most passenger rail transit agencies have employed surveillance on their systems since the 1990s, and some as early as the 1970s.
- The largest single set of locations where electronic video surveillance cameras were used was stations, station platforms, and shelters. Unsurprisingly, systems that came into existence in the past 10 years are more likely to make greater use of video surveillance than older systems.
- More than half the respondents (28 agencies) employed video surveillance cameras in their patron parking areas.
- The same number of agencies (28, though not all the same agencies) employed surveillance cameras onboard vehicles; fewer than half of these (11) indicated their use in operator/cab areas.
- More than half the respondents relied on video surveillance in storage yards, administrative areas, or other nonpublic areas.
- Of the uses presented, ROW surveillance was used least frequently and was most likely to be installed near stations.
- Light rail systems were more likely to employ onboard video surveillance than heavy or commuter rail systems; many respondents indicated that at least 75% of their vehicles had cameras. This difference can be attributed to the age of these systems. Newer systems were more likely to have had video surveillance cameras installed by the rail-car manufacturer and were more likely to indicate that all new vehicles will have video systems preinstalled.
- More than half the video surveillance systems are digital rather than analog, but most are either combined or in transition. The most common special features were 24-hour recording, existence of a secondary power source, and low light resolution. Recent media attention to analytics (“smart” or “intelligent” video) is not yet reflected widely in transit agencies’ existing technology.
- Almost one-half the agencies assign personnel to monitor video cameras on a 24-hour, 7-day-a-week basis; the most common staffing configuration is a combination of police/security and rail operations personnel. Agencies that do not monitor their cameras regularly or at all indicated that personnel costs were the major determining factor.
- Most agencies archive video images, although the retention periods differed substantially from a few days to a year or more. Similarly, access to images is controlled by the agencies; the most common limitation is “designated individuals only,” which most often includes police/security personnel, rail operations supervisors, and risk management personnel.
- The two most common applications of video surveillance were crime/vandalism prevention and accident investigation; the least common application was employee monitoring.

- Few agencies had surveyed patrons on whether the use of video surveillance added to their perceptions of security; fewer still had measured employee perceptions or had consulted employee groups in the decision to install surveillance systems.
- Agencies provided the percentage of funding for surveillance systems from various sources. The largest current funding source for surveillance systems is the Department of Homeland Security (DHS); the next largest funding source was the Federal Transit Administration grant program.

The major conclusions of the study are as follows:

- Reliable funding sources are necessary to assist agencies in making more effective use of available grants to upgrade security systems. The process for obtaining funding for initial purchases or for upgrading existing video surveillance systems is complex and time-consuming. Many agencies rely primarily on DHS for all or most of their funds. The funding process involves a number of agency offices—most often police/security, safety, risk management, information technology, finance, and grant application personnel—which results in a large amount of employee collaboration. However, because funds must be applied for on a yearly basis, it is difficult to anticipate the success of and even more difficult to plan for multiyear projects. Presently, DHS is seen as the largest single source of funding for security training and equipment purchases, and as a result it has a large influence on decisions made by transit agencies regardless of size, location, or mode.
- Agencies are seeking forums to share ideas and best practices. Despite large expenditures for design and purchase of surveillance equipment, transit agencies are highly dependent on vendor claims and on procedures that may require selection of the lowest bidder. Agencies would benefit from a forum to share transit-specific requirements and experiences to balance against unsubstantiated claims; this role could be filled by U.S.DOT or by one or more transit-specific professional associations.
- Policies on image access and retention appear to vary. Transit agencies follow a variety of procedures in these areas; some are guided by state laws pertaining to records maintenance and access but there is little overall guidance in establishing access and retention policies. The forum described previously could provide guidance and uniformity in these areas.
- ROW surveillance is an emerging issue. Relatively few agencies provide any surveillance of their ROWs; those that do provide it primarily immediately adjacent to stations. Though the reasons for this appear to be primarily cost-related, there are also issues pertaining to ownership of the ROW and adjacent areas; how and by whom surveillance equipment would be installed, monitored, and archived; and other questions.
- Publicizing successful applications of video surveillance may result in diversifying funding sources for system installation and upgrading. Because crime/vandalism prevention remains the single largest use of video surveillance by transit systems, agencies might work more closely with local media when malefactors are observed and caught in the act of committing a crime or when video images play a role in post-event investigation of a crime. Publicity given to these types of events may assist agencies in obtaining local funding for installation and upgrading of video systems, resulting in less reliance on the competitive grant structure developed by DHS. However, media attention may result in criticism by groups opposed to the expansion of surveillance systems in public spaces.

Findings from this synthesis suggested a number of major areas for future study. Each is summarized here and briefly expanded on at the end of chapter six.

- Measuring the value of surveillance systems in enhancing patrons' perceptions of security in transit stations, platforms, or shelters and onboard railcars.

- Measuring employee responses to surveillance systems.
- Developing policies on image access and retention, and on legal issues surrounding public access to images.
- Establishing forums to share best practices and assess equipment performance.
- Leveraging internal and external stakeholder input.
- Conducting technical studies of surveillance technology.
- Conducting studies specifically on emerging issues in ROW surveillance and operator/cab surveillance.
- Considering possibilities for partnering with other transit agencies or railroads.
- Considering possibilities for partnering with local government.

Each of these study areas could lead to additional areas that have yet to be thoroughly explored. These and similar studies would assist transit agency managers in making better use of their existing resources and would help them to find imaginative solutions for making more efficient use of video surveillance technology.

## CHAPTER ONE

**INTRODUCTION**

Transit systems in North America, as elsewhere around the world, are faced with law enforcement and crime prevention issues that many rarely thought about two decades ago. In the 1980s and 1990s, transit systems, particularly those in large cities, saw their major law enforcement problems as containing growing numbers of homeless persons who turned stations into encampments and often rode equipment endlessly when they had nowhere else to go. Systems were also concerned with graffiti, which symbolized to patrons that transit agencies which were unable to keep their stations and railcars clean were also unlikely to be able to keep the patrons safe. As graffiti was literally wiped clean from those stations and railcars, “scratchiti,” which involved etching rather than spray painting onto surfaces, presented a newer variation of an old problem.

Transit agencies addressed these issues locally. Larger agencies turned to law enforcement solutions, increasing patrols in stations, on vehicles, and in rail yards. They also relied on emerging crime prevention through environmental design (CPTED) principles, lighting and fencing, and electronic video surveillance to monitor physical property. Smaller systems relied on less labor-intensive or less costly solutions; a few were able to deter rowdy youths and loiterers by following simple steps such as re-arranging furnishings to create fewer private, unobservable spaces within their waiting areas or by playing classical music, which seemed to discourage noisy teenagers from staying any longer than necessary.

Solutions could be tailored to meet local needs because transit agencies are local entities. In contrast to other countries but similar to most public services in the United States, transit providers are numerous and operate independently of one another. The number of systems throughout the country has grown within the past two decades, primarily owing to city or regional governments deciding to wean residents away from car-dependency and onto mass transit as part of their attempts at traffic management and air pollution control. These efforts have resulted in development of a number of new light rail transit systems (LRTs) throughout the country but especially in parts of the west and the south. Today, more than 6,000 agencies are responsible for bus, rail, ferry, and other transit modes (Guerrero 2002, p. 5).

At a time of heightened concerns over safety and security, driven in large measure by international terrorists who have

targeted transit systems around the world, individual transit providers are responsible for the safety and security of patrons, employees, stations, and vehicles. In the event of rail systems, this concern extends to their rights-of-way (ROWs), which throughout this synthesis rely on the U.S.DOT’s Federal Railroad Administration (FRA) definition of the pathway on which a train travels and that any piece of equipment or person within 25 ft of the track is considered to be in the ROW. Although transit agencies may receive assistance from all levels of government, starting with their cities or counties and also including federal assistance primarily from either the U.S.DOT’s Federal Transit Administration (FTA) or from the Department of Homeland Security (DHS), the primary responsibility for securing each of these transit systems rests with the individual transit agencies. Commuter rail agencies, which are regulated by the FRA rather than by the FTA, are also eligible for a number of safety and security grants as well as for funds under the Federal Highway Administration (FHWA) Highway-Rail Crossing Program.

The job is huge. In 2000, mass transit systems provided more than 9 billion passenger trips and employed more than 350,000 people; by 2002, about 14 million people in the United States relied on mass transit each workday. More recently, in 2009, estimates were that public transit accounted for more than 10.2 billion trips annually (Guerrero 2005, p. 5; Stelter April 5, 2010).

The complexity of providing security for passenger rail transit goes beyond the often-discussed need for transit agencies to balance security with concerns about accessibility, convenience, and affordability. The decision to use public transit in most parts of the United States is discretionary; only in highly urbanized areas such as New York; Philadelphia; Boston; Washington, DC; Chicago; San Francisco; and Los Angeles are highway and street congestion sufficiently dense and parking costs sufficiently high to discourage the use of personal automobiles by most commuters and by occasional patrons traveling to recreational or cultural activities. Although this is changing in many areas, where the travel time from home to work has begun to impact the use of automobiles, in most parts of the nation rail transit agencies continue to compete for riders with private automobiles.

A number of factors affect transit usage. Although the cost of gasoline and concerns with pollution are factors some

consider, this concern competes with riders' other perceptions. Many, for instance, are concerned with limited service during non peak periods. The consistency with which transit agencies in less densely populated areas offer some variation of an emergency ride home program indicates their recognition of the concern by patrons that using mass transit rather than traveling in their private vehicles limits their freedom if their regular travel schedule is for some reason interrupted.

The conventional wisdom states that a controlled access system in public transit even remotely similar to today's airport travel experience will discourage patronage. There are also concerns about the costs of instituting such controls. The few experiments around the country that tested airport-like passenger and baggage checks were just that—tests—which generally reinforced the incompatibility of such systems with the culture and infrastructure of public transit. A major finding of a lengthy study of passenger screening concluded that: "Screening 100 percent of urban mass transit passengers is not a realistic security option" and that "[t]he human resources required, added security costs, and delays would destroy urban mass transit" (Jenkins and Butterworth 2007, p. 5). Various combinations of either selective or random baggage inspections and targeted but brief interviews of patrons add uncertainty and may deter those with evil intentions. Although they provide a measure of risk reduction to an agency and its patrons, they are not realistic long-range solutions to safeguarding open systems with multiple access points. Technological and scientific advances may at some time in the future alter this determination. But because transit systems need to develop risk reduction and security solutions that are more immediately available, electronic video surveillance systems have become the preferred technology.

No one likes to mention dollar values when lives may be at stake. Amid all the discussions of safeguarding surface transportation systems, one government survey of ten large transit agencies noted that their top three safety and security funding priorities were communication systems, video surveillance equipment, and additional training. Based on estimates developed by eight of the ten, the cost of those improved measures for just those eight systems totaled \$711 million (Guerrero 2002, pp. 9–10). The total for all agencies would be in the billions of dollars.

The logistics of instituting such controls are equally overwhelming. The sheer number of independent transit systems makes any form of centralized control, even by the federal government, unlikely. As aptly pointed out by a report prepared by White House staff, "surface transportation modes differ significantly based on size, location, ownership, capacity measures, and redundancy of operations," leading to challenges in prioritizing assets and systems (*Surface Transportation Security Priority Assessment* 2010, p. 15).

Not mentioned in the report but adding to the complexity are the widely varying methods of securing and policing public transit. These methods are as different as the systems themselves. Methods range from virtually no staff assigned solely to security to large, full-service police departments. Although many transit police agencies are concerned about publicizing the sizes of their staffs, this information is often available on their websites, in local news stories, or in testimony by chiefs before various local, state, and federal oversight agencies. All figures in the synthesis for agency staffing and for funds obtained from various outside sources are from published materials or were provided to the authors by the agencies.

Among the largest full-service transit police agencies are New York–Connecticut's Metropolitan Transportation Authority (MTA), with more than 600 officers, and the Port Authority of New York and New Jersey's (PANY&NJ) police staff of more than 2,000 (most of which are not assigned to passenger rail but with specialized department resources available as needed). Transit police departments of this size are rare. Amtrak, the national passenger rail agency, has about 500 police officers, while the New Jersey Transit (NJT) police department, responsible for rail and bus transit throughout the state, has about 250. Other agencies, including those that responded to this survey, have about 200 officers, although some, again including survey participants, are considerably smaller, including agencies selected as case study participants.

A number of agencies contract with local police or county sheriffs' offices to provide patrol services and sometimes also investigations of past crimes. The amount of control the transit agency has over these officers differs depending on the actual wording of their contracts with the police agencies or with local custom. Generally in these arrangements the transit agency receives specialized services in addition to patrol, such as emergency response to accidents or incidents, and use of, for instance, evidence or bomb technicians as needed.

Other agencies employ no or very few persons with police authority but either employ or contract for security personnel who work solely for that transit agency. In some jurisdictions these security officers may be armed, in others they do not carry firearms. Again depending on agency needs or local licensing regulations, these security officers may have some level of police authority or they may be authorized solely to act as "eyes and ears," calling for local police as needed. One case study agency, the Altamont Commuter Express (ACE) in California, has no dedicated police or security officers of its own. It relies on the local police departments whose jurisdictions it travels through, the Union Pacific Railroad (UPRR) on whose tracks it travels, and the Amtrak police, with which it shares several stations, for its law enforcement.

This synthesis is not a review of policing configurations within the transit industry. Yet information assembled on decision-making on where to install or how to make use of electronic video surveillance equipment and technology often was influenced by how an agency set up its police or security department, even though decisions on surveillance technology and its uses are rarely made by only one transit agency department. Generally a committee that involves police/security, safety, risk management, rail operations, information technology (IT), and grant-writing specialists ensures that many internal stakeholders are invested in the final decision. Internal staff may also be augmented by consultants, especially for the initial installation of an electronic video surveillance system or when it is part of an extension to the existing transit system.

Anticipating that different agencies might put their video surveillance systems to different uses, the study located and queried 58 U.S. heavy, commuter, and light rail passenger transit agencies. Some agencies had been in existence for many decades, some were relatively new, and some had not yet entered revenue service. Many of the agencies are multimodal; the synthesis questionnaire focused on only the rail modes under the systems' control. Some of the newer agencies have had video surveillance in their stations, parking lots, and onboard vehicles since their inception, whereas older agencies are faced with the challenge of retrofitting stations that were not designed with video in mind. Forty-three agencies completed the questionnaires, a response rate of about 73%. Five agencies offered their programs as case studies to document different aspects of the roles that video surveillance can play in an overall security or risk management program. Because of the high response rate reflecting such a wide range of agencies, the synthesis provides a unique perspective. Its focus is not solely on homeland security concerns or on large, urban agencies with their own police departments. Nor is it solely on crime control; the role of video surveillance in risk management and in monitoring employee work sites is also considered, because terrorist threats cannot be separated from other concerns facing transit agencies. In the area of crime control, any concerns an agency may have over being a terrorist target will overlap with concerns about criminal acts.

In addition, terrorism concerns are not the same for all agencies. Not all facilities are equally attractive to terrorist groups. The attractiveness of a particular target may be based on a facility's financial value or its symbolic value, and may include the effect its disruption or destruction will have on the local economy, or on creating fear and disruption at the local, regional, national, or even international level. International terrorists, for instance, are likely to want to cause multiple deaths and injuries, and therefore are most likely to strike where patrons will be the victims and where maximum press coverage will be obtained. Domestic terrorists and activist groups are generally less eager to kill and

more interested in bringing publicity to their cause, which may make the transit system itself the more attractive target. For instance, causing trains to run late by mass trespassing on the light rail tracks or creating a noisy disturbance in front of or in a station will more likely suit the purposes of a community action group than would destroying a station or derailing a train. These groups are unlikely to want to cause numerous deaths or to put the transit system out of operation for days or weeks or longer. However, international and domestic terrorist groups share the need to enter onto the system to evaluate where they want to place any deadly devices or to cause their nonlethal commotions. The role of electronic video surveillance in these instances is to alert those protecting the system of suspicious persons or activities, whether terrorists or nonterrorist potential criminals (whose behavior is more likely to involve planning a robbery, theft, or act of vandalism).

Stations are not the only areas of vulnerability for a transit system. Employee areas, equipment yards and storage areas, electrical or traction power substations or junction boxes, the overhead contact system, and the ROW itself are targets for thieves, vandals, or terrorists. In such incidents, particularly if terrorism is not suspected, vulnerability to safety hazards play as important a role in decision-making as do security issues.

In addition to concerns over stationary facilities, transit agencies need to prevent injury and criminal activity on their moving targets: the railcars. Agencies have also begun to consider what role electronic video surveillance might play in addressing the vulnerability of ROWs, where the difficulty of locating perpetrators of violence was illustrated by the as-yet-unsolved derailment of Amtrak's Sunset Limited in Hyder, Arizona, on October 9, 1995.

## PROJECT BACKGROUND AND OBJECTIVES

This synthesis investigates the implementation and use of electronic video surveillance by passenger rail transit agencies to protect patrons, employees, railcars, and infrastructure. It describes the current state of practice, including what is being surveilled; whether systems are monitored regularly and, if so, by whom; whether the images have been used in criminal or civil prosecutions; and whether the surveillance systems have resulted in fewer claims of injury or loss. Funding sources are also explored. The objectives can be summarized as follows:

- To provide a brief history of the use of electronic video surveillance technology by transit systems in the United States and internationally.
- To describe the current use of surveillance technology by passenger rail transit agencies, including heavy rail, commuter rail, light rail, and monorail and funicu-

lar systems, by examining where the technology is employed, including in stations, onboard vehicles, and along ROWs.

- To examine agencies' experiences on how successful the technology is for crime/vandalism prevention; fare collection/dispute mediation; other complaint resolution; accident investigation; employee monitoring, or other uses.
- To summarize findings on a number of relevant legal issues, including archiving of and employee access to images/records, whether patrons are notified of the presence of surveillance, and policies for public access to images/records.
- To summarize funding sources for surveillance systems.

The synthesis draws on the findings of earlier TCRP syntheses, particularly *Synthesis 38* (Maier and Malone 2001) and *Synthesis 80* (Nakanishi 2009) as well as *Improving Transit Security* (Needle and Cobb 1997) and *Guidelines for the Effective Use of Uniformed Transit Police and Security Personnel* (Interactive Elements Inc. 1997). However, the study differs substantially from these earlier works because it focuses solely on passenger rail transit agencies and it describes uses of surveillance technologies beyond crime and terrorism. Similar to the other studies, though, a major focus of this synthesis is to provide transit agencies with a current snapshot of how passenger rail systems use surveillance systems and to help agencies decide how and where to employ this expanding technology.

## METHODOLOGY AND SCOPE

The following methods were employed to achieve the multiple aims of the synthesis:

- Reviewing articles in academic and popular journals and government and transit-specific studies and reports. The most relevant can be found in the literature review.
- Investigating the introduction of video surveillance as a law enforcement tool in transit systems and its current uses in such noncriminal enforcement areas as claims adjustment, risk assessment and management, employee safety, and integrity control.
- Developing, distributing, and analyzing the results of a questionnaire survey sent to 58 U.S. passenger rail transit agencies of varying sizes and modes.
- Conducting case studies.

## Literature Review

The literature review of relevant materials includes articles in academic journals and in popular magazines written for law enforcement/security, safety, risk management, and IT

professionals. It includes a variety of government reports and studies undertaken on behalf of an array of agencies. Technical materials published by surveillance system vendors were reviewed, as were media announcements from a variety of transit agencies that are upgrading their video surveillance systems. In recognition of the growing attention being paid to video analytics (often termed "smart" or "intelligent" video), articles in this area were also reviewed. The literature review is presented as an annotated bibliography following the conclusion, chapter six. It summarizes the publications and documents that seemed most relevant to synthesis readers and that were readily available online or from the publishers.

## Questionnaire Survey

A survey questionnaire was developed and sent to 58 agencies, including established rail systems and those operating for only a few years or about to enter revenue service. The systems, a number of which are multimodal, varied widely in size and scope relating to numbers of passengers and numbers of railcars and stations. (Appendixes A and B contain a copy of the questionnaire and a list of the responding agencies.)

Questionnaires were sent primarily to police/security and/or safety directors by means of a group email from TRB. Subsequent emails were sent individually by the project's authors. Throughout the questionnaire phase, names of recipients were updated as information was received from the transit systems to ensure a maximum level of participation. Eliminating duplications where questionnaires were sent to an agency's security manager as well as to the local police who patrol the system resulted in a total population of 58 individual agencies; responses were received from 43, resulting in a response rate of 73%. The percentage of respondents is well in excess of the acceptable range and reflects the largest collection of data solely from passenger rail agencies on issues pertaining to the use of electronic video surveillance.

## REPORT ORGANIZATION

Following the summary, chapter one introduces the project and its objectives and explains its methodology, scope, and organization. Chapter two provides a history of the use of video surveillance in transit operations, its role in crime prevention and detection, and its role in risk management and internal control systems. Chapters three and four are based on the questionnaire responses; chapter three documents how systems are employing video surveillance, and chapter four discusses administrative considerations that make up a coherent video surveillance policy, as well as describing funding sources for purchasing and upgrading existing systems. Chapter five contains case studies of how individual agencies are using their video surveillance systems. Finally,

chapter six provides conclusions based on the findings of the case studies and questionnaire responses, and presents items for further research. These chapters are followed by

references, an annotated bibliography, and appendixes that include the survey questionnaire and a list of participating transit agencies.

## DEVELOPMENT OF ELECTRONIC VIDEO SURVEILLANCE IN TRANSIT SYSTEMS

The impact of the September 11, 2001, attacks using airplanes as weapons of destruction has had an incalculable impact on discussions of transportation security. It is reflected in virtually all post-9/11 literature; it is almost impossible to find any discussion of surface transit security measures that focuses on nonterrorist-related safety or security concerns. This focus has intensified since the subsequent terrorist activities involving transit systems in Madrid, Spain, on March 11, 2004, in London, England, on July 7, 2005 (where surveillance technology played a role in post-event investigation), in Mumbai (Bombay), India, on July 11, 2006, and in Moscow, Russia, on March 29, 2010, while this study was under way.

In addition, the May 1, 2010, attempted bombing in New York City's Times Square, where the transit system was not the primary focus of the attack but would have been seriously affected by it, led New York City Mayor Michael Bloomberg to renew his call for an expanded surveillance network. At the same time, images of someone who turned out not to be a suspect but were widely circulated led to debate among security professionals about the value of video as a preventive or a post-incident (forensic) investigatory tool.

The debate was tempered when, within weeks of the Moscow bombing and the failed Times Square bombing, India suffered yet another terrorist attack on its rail system. In this incident, on May 28, 2010, a Mumbai-bound passenger train collided with a freight train after someone sabotaged tracks in the state of West Bengal, resulting in more than 70 deaths and more than 100 injuries only 1 week after the same suspects were believed to have blown up a bus carrying civilians and police officers. Although a Maoist group was blamed for the crash, within days the Communist Party of India said that it was not involved. India has not provided information on who else might have been responsible and has continued to view the Maoists as the most likely perpetrators ("India: Maoists Deny..." 2010).

Thus, while the current synthesis focuses on the uses of video surveillance for broader purposes than terrorism concerns, the literature review is skewed in that direction owing to the single-issue focus of many of the recent studies. But vulnerability measures taken to prevent terrorist attacks from occurring also have applicability to general crime pre-

vention and to patron and employee safety. In the *Transportation Research Record*, Aaron Eder observed that "good security systems can increase the difficulty of terrorist operations, increase the likelihood of terrorists being detected, minimize injuries and loss of life, decrease panic, and calm riders during times of panic." This is equally true for less dramatic events on transit systems (Eder 2001, p. 94).

A chronology of terrorist events against transit systems compiled by the Norman Y. Mineta International Institute for Surface Transportation Policy Studies Institute (MTI) listed close to 4,000 events between January 1972 and August 2004 (*Designing and Operating Safe and Secure Transit Systems* 2005). Other studies, which are often based on similar or overlapping databases, have reported similar numbers. One study estimated that rail-related attacks, none in the United States, averaged 30 per year between 1998 and 2003 (Peterman 2005). More recently, in a commentary following the Moscow bombings, former TSA administrator Kip Hawley and his co-authors counted 11 ground transportation incidents versus 53 attacks on airline and airports during the same time period (Hawley et al. 2010).

Regardless of the actual numbers of incidents and how these compare with those on other transportation modes, terrorist activity on rail systems around the world has influenced the utilization of electronic video surveillance technology well beyond its original use primarily as a passenger traffic control and risk management tool.

### HISTORY OF ELECTRONIC VIDEO SURVEILLANCE IN TRANSIT

Despite this exhaustive focus on antiterrorism electronic video surveillance, its uses have always been far broader. The earliest uses of video surveillance were associated with passenger traffic control and managing risk related to overcrowding, nonpayment, fire, and accidents and injuries. Subsequently, surveillance came to be viewed as part of crime prevention strategies, especially as these began to concentrate on the intertwined roles of deterring crime while also enhancing patron perception of safety. Initially, video monitoring was employed primarily to assist in fare compliance. Cameras were placed in entry areas to allow for observation

of ticket vending machines (TVMs) and, particularly in the London Underground (LU), to assist station personnel in monitoring areas of dangerous crowding on platforms and escalators.

As with so many innovations in law enforcement, the initial uses of surveillance cameras are difficult to pinpoint. Some observers trace their use to covert surveillance by individual agents or private investigators taking photos of suspects engaged in various incriminating behaviors. Without going so far as to link the use of surveillance in the transit environment to such covert activities, its use was reported as early as the 1970s.

*Policing Urban Mass Transit Systems*, one of the first federal reports that dealt specifically with policing mass transit, observed in 1979 that several properties had or were planning to install video surveillance equipment to monitor station activities. Seen in the broader context of using technology to assist police, the move was compared to silent alarms and two-way radios as adjuncts to or replacements for patrol operations. Just as today, the “constant surveillance capabilities” were seen as having “the potential to deter offenders, aid police in detecting crimes and apprehending criminals, and provide patrons with a sense of security.” But the researchers also noted that even where installed, surveillance systems were not “well integrated into police day-to-day operations,” in large part because the cameras were monitored by transit operations personnel (1979, p. 15).

The findings of this synthesis confirm that many surveillance systems continue to be monitored by transit operations personnel but this was not perceived as a problem by respondents. Of the 40 agencies that responded to the question concerning who monitors their video systems, the largest number (22) reported the task was performed by a combination of police/security and rail operations personnel, 8 by rail operations personnel, and 10 by police/security personnel. None of the agencies saw this as hampering law enforcement activities; the combined roles of police/security and rail operations personnel seemed to be a successful application of system integration that maximized the benefits of video surveillance monitoring. It permitted observation of and response to operating hazards at the same time as preventing vandalism or criminal activity, all of which may affect rail operations.

The 1979 report documented that law enforcement was rarely the primary goal of the surveillance systems. For instance, San Francisco’s Bay Area Rapid Transit (BART) was described as having installed its video cameras primarily to monitor elevators for the disabled community and only incidentally for security. Port Authority Transit (PATCO) used its video in conjunction with a public address system and a direct-line emergency telephone system primarily to assist patrons having problems with the automatic fare col-

lection system and secondarily to deter and apprehend fare evaders. Only the Port Authority Trans Hudson (PATH) rail line connecting New York and New Jersey (operated by the PANY&NJ) was at the time using surveillance solely as part of its crime prevention strategies (*Policing Urban Mass Transit Systems* 1979, p. 38). In addition, Philadelphia experimented with surveillance in 1978 in conjunction with patrols in the transit system by plainclothes officers assigned to cut down on the growing graffiti problem (Hackney 1978).

The situation changed considerably over two decades. *Guidelines for the Effective Use of Uniformed Transit Police and Security Personnel*, a 1997 TCRP report by Interactive Elements Inc. on transit policing and security deployment tactics, found that a dozen rail agencies employed video surveillance in stations, parking lots, bus terminals, rail stations, elevators, and onboard vehicles: BART, the Greater Cleveland Regional Transit Authority (GCRTA), the Los Angeles County Metropolitan Transportation Authority (LACMTA), Maryland’s Transit Administration (MTA-MD), Miami’s Metro-Dade Transit (MetroRail), the Metropolitan Atlanta Regional Transportation Authority (MARTA), the Long Island Rail Road (LIRR), New York City Transit (NYCT), NJT, Denver’s Regional Transportation District (RTD), the Southeastern Pennsylvania Transit Authority (SEPTA), and the Washington, DC, Metropolitan Area Transit Authority (WMATA). The technology was used primarily to document incidents in progress, to facilitate officer response by having staff responsible for monitoring the video dispatch officers to these incidents, and to assist in post-event investigation and prosecution of offenders by providing a record of criminal activity and a positive identification of the person(s) responsible for the act (pp. 156–157). This synthesis found that transit agencies still use video surveillance primarily for these purposes.

## VIDEO SURVEILLANCE AND RISK MANAGEMENT

Although video surveillance technology is today most frequently discussed in the context of terrorism, a review of the history of the uses of surveillance systems in transit agencies points to its primary use as a risk management tool against fare evasion and as a defense against fraudulent claims, particularly for individuals alleging injury during accidents. Its use as a tool in crime prevention and detection, to allay patron fears that transit systems were unsafe, was secondary.

Two recent TCRP studies pointed to the continuing importance of risk management issues in the installation of video surveillance systems. The current synthesis reinforced the continuation of this role. Although use of video surveillance anywhere on a transit agency’s property assists in risk mitigation, its use in nonpublic areas such as yards and employee areas are traditional uses that continue to be among the most common. Of the 43 responding agencies, 26

reported use of video surveillance in storage and other yards and 20 in employee/administrative areas.

In a 2000 TRCP synthesis, *Identifying and Reducing Fraudulent Third Party Tort Claims Against Public Transit Agencies: A Synthesis of Transit Practices*, M. Patricia Maier provided a number of examples of how transit agencies were using surveillance video images to take action against fraudulent claims (2000, pp. 29–31). Fraudulent claims can mean many things, including, commonly, verification of insurance claims resulting from accidents or injuries (real or alleged) from patrons, employees, or trespassers. Because the issue of fraudulent claims by employees is more controversial than the other categories and because such surveillance is more likely to be covert rather than overt, the existing literature tends to focus on discussions of external rather than on internal fraud.

External fraudulent claims may occur through a variety of events. For instance, people who were at an incident may claim to be injured when they were not, and people who were not at an incident may also claim to have been injured. In some cases, these so-called “ghost riders” have been observed on video actually rushing to enter a disabled vehicle, more often a bus than a railcar, so that they may claim an injury resulting from the accident. SEPTA conducted a study in 1988 that showed that between two and three times as many people were filing lawsuits as had been injured in accidents, including those who were not even onboard the vehicles. Maier (2000) described a SEPTA subway accident in 1990 that killed four people and attracted claims from almost 300 people who alleged to have been injured, a figure that was far in excess of the number of passengers onboard at the time.

Because video surveillance onboard vehicles has been until recently more likely to be installed on buses than railcars, similar bus-related findings are quite common. Again from SEPTA, Maier cited an instance when lawsuits were received following a bus/car accident even though the bus had carried no passengers at the time of the incident. Similarly, a sting operation that created a staged accident in New Jersey resulted in video of 17 bystanders scrambling onto a bus that had been hit by a car; all later claimed to have been injured. Bus companies in urban areas of the state reported that buses involved in accidents were often surrounded by “runners” working for doctors and lawyers who would get on the bus to distribute leaflets with the names and phone numbers of their employers, encouraging passengers to claim neck or back injuries so that they could file claims against the carriers.

Another TCRP study, *Electronic Surveillance Technology on Transit Vehicles*, reported that almost half of responding agencies used surveillance recordings to disprove claims made against their systems. Once again, SEPTA provided a number of examples. The Philadelphia-based agency

reported that during its implementation of onboard surveillance in the mid-1990s as part of a larger program aimed at targeting fraud, claims dropped more than 30%. Although the report did not specify whether the cameras were used only on buses, only on railcars, or on some combination of the two, it noted that based on the entire program, SEPTA estimated its claims-related savings at more than \$2 million annually (Maier and Malone 2001, pp. 19–20). Also involving SEPTA, Maier and Malone (2001, p. 25) reported on a 1995 case in which a plaintiff who sued for injuries allegedly sustained during a sudden stop added a claim of emotional distress after learning that SEPTA had relied on video surveillance to monitor the plaintiff’s actions. The court sustained SEPTA’s defense that the surveillance was not intrusive and violated no rights claimed by the plaintiff.

In addition to saving lives, there has been considerable discussion along these lines as to the benefit of video surveillance at rail crossings to help to mitigate liability after crossing accidents, particularly in conjunction with tests to ensure that flashing lights and gates were operable. A recent accident involving an Amtrak train and a car carrying five young people (the 19-year-old driver and four others between the ages of 14 and 21, all of whom were killed in the accident) illustrates this. Within 24 hours of the crash, police released a copy of a video image that showed the vehicle skirting the railroad gate despite the gates and flashing lights operating. The train, Amtrak 353, going from Detroit to Chicago and carrying about 150 people, was traveling within speed limits when it broadsided the vehicle on tracks owned by Norfolk Southern (Runk 2009).

Grants available from the FHWA’s Highway-Rail Crossing Program are intended, in part, to address these safety-related issues, but responses to the synthesis questionnaire showed that none of the responding agencies had received funds from this source. The wording of the funding question made it impossible to determine whether funds had been applied for and not approved or whether this is an untapped resource for passenger rail agencies.

The importance of surveillance as a risk and fare compliance tool persists. In 2005, a report prepared for Sound Transit (Seattle, Washington) in conjunction with its Regional Transit Long-Range Plan recommended video surveillance for monitoring TVMs and general fare collection protection and did not mention it in any other capacity (*Sound Transit Long-Range Plan Update* 2005, p. 20). Video cameras are often placed in locations where it is possible to monitor fare collection points. As surveillance technology has become more common, it may also prove its value to transit in detecting vendor fraud. This occurred recently when a school system discovered, based on its video system covering areas outside its main buildings, that a company being paid for snow removal billed for more trucks than were sent to the site (Stelter March 2, 2010).

## EXPANDING THE DEFINITION OF RISK

In recent years, defining risk has often revolved around discussions of the readiness to avoid and the capability to respond to terrorist acts. But the same factors that make public transit vulnerable to terrorism also make transit agencies vulnerable to other types of crimes and to claims of injury or loss of property. For example, unlike airports, transit systems do not have either single or closely watched points of egress and access. Transit vehicles travel in predictable paths at predictable times along ROWs that are generally unguarded and easily accessible to the public. Brian Jenkins, who has written extensively on transit terrorism, has observed that for those individuals who are intent on killing in quantity and willing to kill arbitrarily, transit provides the perfect target in part because it provides anonymity and an easy getaway (Jenkins 2001). The same conditions exist for other, nonterrorist crimes and also for traditional risk management concerns such as claims of loss of property and injury by employees, patrons, or trespassers.

In recent years rail agencies have recognized the intertwining needs of crime prevention—whether related to terrorism or any criminal event—and safety. Safety and security concerns are enumerated, analyzed, and ranked using similar methodologies. Each analysis is similar to a traditional risk assessment and is required as a condition of receiving funds from DHS or approval under FTA's New Starts programs. These assessments, whether called threat and vulnerability assessments, hazard analyses, or risk registry reviews, are intended to establish that an agency is aware of and has provided satisfactory provisions for the detection, deterrence, and response to safety hazards and security vulnerabilities.

Thus, the recognition of a role for electronic video surveillance in both risk management and crime prevention did not occur in a vacuum; it was part of a developing literature in the 1970s on theories of crime prevention and also reflected growing concerns by transit managers that patrons perceived transit systems as unsafe. Current discussions on video surveillance as a potential terrorist detection tool and its use in post-event investigation are a continuation of its crime prevention applications. These new uses have been made possible by technology that permits more accurate identification of persons and objects than the earliest systems were capable of providing.

### Influence of Crime Prevention Theories

The expansion of video surveillance from a risk management to a law enforcement tool was also influenced by the emerging theories of crime prevention through environmental design (CPTED) and situational crime prevention (SCP). These theories altered the way transit agencies addressed

security as transit managers recognized that the public's perception of security influenced their travel decisions.

CPTED grew out of the concept of "defensible space" formulated in the late 1960s by the architect and urban planner Oscar Newman. Newman recognized that the design of the physical environment could create opportunities for people to come together and in doing so remove the opportunity for criminals to act without the fear of being observed. In this view, design features enhance or inhibit the possibility of crime occurring in a specific place by producing either positive or negative behaviors by those who enter the premises. At the same time, places that are designed in ways that seem to inhibit crime (clean, well-lit, and offer few hiding places for the ill-intentioned) also foster feelings of security. Patrons sense that those responsible for the site are in control even if they do not actually observe uniformed transit employees present.

The theory was expanded in the late 1970s by what have come to be known as SCP theories. The first of these, commonly referred to as opportunity theory, states that offenders will commit crimes wherever two factors converge: suitable targets and an absence of protection. Added to this, the rational choice perspective stated that, with the exception of rare crimes of passion, offenders make rational choices that involve weighing the pros and cons of committing particular crimes in particular areas (Cohen and Felson 1979; Cornish and Clarke 1986). A nonviolent adaptation of these theories is the "ghost riders," who calculated that they could allege phony injuries because no one was on the buses or railcars to report their fraud. The disabled bus or railcar was a suitable target on which to commit fraud because there were no guardians to note their fraudulent behavior.

SCP can be viewed as an action plan for combating crime or fraud. Broadly speaking, its premise is that the physical environment can be managed to control both the fear of crime and the likelihood of its actual occurrence. Whereas CPTED focuses on physical design elements to minimize vulnerabilities, SCP includes cleanliness, type and amount of staffing, and more general target-hardening techniques.

A plan in barrier-free systems to resolve a problem of patrons ignoring TVMs and failing to pay their fares illustrates how the theories overlap and also the role that video surveillance continues to play in detecting fare evasion. A solely CPTED-based solution to payment fraud would involve moving the payment area to a location more easily visible to general users or to agency security personnel, but this may not be possible in an older system. An SCP-based solution would add environmental deterrents to any built-in environmental controls, such as the possibility of external surveillance (general video monitoring) and plainclothes officers to observe, arrest, and prosecute violators. In this example, video monitoring alone may not correct the prob-

lem, but in all likelihood, particularly with appropriate signage, it will encourage some nonpayees to pay rather than risk being caught on video. If combined with the ability of the person monitoring the video to speak directly to the nonpayees or to direct an officer to the scene, this system is likely to deter all but the most persistent nonpayees.

CPTED is particularly valuable in the initial design of a transit system because it makes use of natural surveillance and access control, and territorial reinforcement to assist agency personnel in fostering an environment that minimizes the opportunity for crime. In effect, it uses physical arrangements to produce socially-acceptable behavior that will reduce actual crime and also the fear of crime. But because perfect CPTED solutions are rarely available, even in new construction, SCP-based solutions, particularly electronic video surveillance, have become the most common backup plans.

### **New Transit Systems Incorporate Design Improvements**

The idea of designing new transit systems based on CPTED features while also incorporating surveillance technology was pioneered with the construction of WMATA, which began operation in 1976. Much studied by transit professionals and academic researchers, WMATA was described as “crime free” and labeled “one of the safest subway systems in the world” based on its architectural design, which used crime prevention principles, vigilant maintenance policies, and stringent enforcement of rules (LaVigne 1996, p. 163).

Recognizing that the architects and planners had the luxury of starting from scratch rather than having to accommodate existing technology and design, much was made of the system’s high ceilings and uniform 600-ft-long platforms. In addition to their length, the platforms were straight and relatively pillar-free, with few indentations or places for those with ill intentions to hide. This also contributed to a feeling of spaciousness and standing room free of having to crowd in on other patrons, all elements viewed by crime prevention specialists as adding to passenger comfort and feelings of security.

Although deep below street level (the system has some of the steepest escalators of all U.S. transit systems), platforms were well lit and immaculately maintained. In addition to a uniformed attendant on each mezzanine, every station was designed with a minimum of eight surveillance cameras in operation, placed at the ends of each platform and on ceilings at entrances and exits. Elevators were also equipped with surveillance cameras. Relying on the police theory of the dual message of omnipresence, namely that a visible police officer sends a message to the ill-intentioned that there is a high probability of being caught in a criminal act and to the well-intentioned that the law enforcement presence provides security by deterring the ill-intentioned, WMATA’s first

police chief, Angus MacLean, said the cameras were purposely left visible to riders and to alert potential criminals that they were being monitored. He admitted, though, that the cameras served mostly a psychological purpose because they were viewed only at the station manager’s kiosk, which was often unattended (LaVigne 1996, p. 174).

Probably unknown to patrons, was that the video screens were not monitored by police officers, but by civilian attendants who used two-way portable radios to contact police more quickly than in most of the older transit systems. This deployment has not changed; today, most surveillance monitors are viewed by some combination of civilian rail operations personnel and by police/security officers. As indicated previously, this system integration allows the video network to maintain safe and efficient rail operations while also observing possible vandalism or criminal behavior.

Regardless of who was watching, WMATA received considerable publicity for instances when patrons were warned by someone monitoring the surveillance system not to stand too close to the platform edge or to pick up trash they had dropped somewhere other than into the receptacles provided. WMATA was not the only agency that used it video surveillance for basic order maintenance. In an article discussing the expanded use of surveillance, *The New York Times* reported on an incident at the Hoboken, New Jersey, PATH station where a couple was startled to hear a voice from the police command center at about 2 a.m. reminding the male to put out his cigarette and asking him and his female companion to take their feet off the bench (Halbfinger 1998).

Though these examples might seem amusing or even petty, it is unlikely that patrons getting such messages will consider participating in serious vandalism or criminal behavior. Unstated also is that it is likely to discourage employees from shirking assigned duties or undertaking other inappropriate behavior as long as cameras are known to be in use.

As with WMATA, MARTA, established in 1972, also was designed as a wholly new entity and also included electronic surveillance technology from its inception. In addition to constant surveillance in the stations, MARTA included other designed-in risk mitigation and crime prevention technological advances such as passenger intercoms, emergency phones, and anti-passback fare gates. The emergency phone system was more extensive than most rail systems and relied on a variety of color-coded phones; white phones were designated for passenger assistance, blue phones were linked to zone centers where personnel monitored video cameras, and red phones were designed as fire phones (*Guidelines for Effective Use...* 1997, p. 40).

As new systems were developed that included electronic video surveillance, its use underwent a dramatic change

throughout the transit industry. By the 1990s, surveillance had become a fairly regular feature in stations, employee facilities, and parking lots. Its installation on railcars and along ROWs was and continues to be far more limited.

In addition to WMATA and MARTA, other urban transit systems made use of video surveillance in passenger stations as early as the late 1970s and early 1980s; today almost all do. One early adopter, Chicago's Metra, monitored several stations with a system that was originally intended to protect TVMs, again illustrating the overlap of fraud detection with crime prevention. Metra officials found the cameras acted as a significant crime deterrent, which led to retrofitting them with wide-angle lenses to include larger sections of the stations. Both the St. Louis Bi-State Development Agency (MetroLink) and Cleveland's GCRTA reported successful applications of video monitoring at key rail stations. The GCRTA also used video to monitor revenue facilities. The Niagara Frontier Transportation Authority (NFTA, Buffalo, New York) used surveillance to view more than 90 of its locations. Although at this time, most of the in-vehicle monitoring took place in buses rather than on railcars, the NFTA reported some success with cameras to deter incidents on some light rail vehicles (LRVs) (Gilbert 1995, p. 22).

#### **THE LONDON UNDERGROUND'S INFLUENCE ON TRANSIT SURVEILLANCE SYSTEMS**

To most North American transit managers, the transit system most closely associated with the introduction of video surveillance is the London Underground (LU) in the United Kingdom. One of the first systems to employ video surveillance, the LU's vast network of cameras attracted worldwide attention in the aftermath of the attacks on July 7, 2005, when suicide bombers who claimed an association with al Qaeda set off three bombs in LU trains and on one London bus, killing 52 people and wounding more than 700. Two weeks later, on July 21, terrorists planted an additional three bombs on the LU and on another London bus, but this time the devices failed to detonate.

By the time of the second attempt, authorities had already identified the first set of bombers based in part on a closed-circuit television (CCTV) image of the four men at the Luton train station, about 50 miles north of London, at about 7:20 a.m. on the day of the attacks. The black-and-white photo showed all four men carrying backpacks; additional evidence indicated they had traveled together to the King's Cross Station. The wide publicity given to the video image of the four men by the London Metropolitan Police, in what the Canadian Broadcasting Company on Aug. 11, 2005, called "the largest crime scene in British history," ("London police investigation timeline," 2005) has influenced at least part of the current push to increase the use of video in U.S. transit systems. Yet this instance also reinforced that video may

serve more appropriately as a post-crime investigative tool than as a crime deterrent or prevention mechanism. The role of video for either prevention or post-crime investigation may be less relevant for terrorism than for traditional crime, particularly where suicide bombers are unconcerned with the consequences of their actions and may actually hope for recognition as a way to further their cause.

At the time of the July 7 bombings, the approximately 275 LU stations were observed by more than 6,000 cameras; that number was expected to double by 2010. By the end of 2005, the British Transport Police, which is responsible for rail policing in England, Scotland, and Wales, comprised about 650 officers and was expected to hire about 100 additional officers in 2006. These figures are difficult to substantiate, but both the numbers of cameras and of police officers have grown.

The original purpose of the LU's video system was to assist station personnel monitoring crowd control. It was introduced on the Victoria Line in 1968 and spread with the introduction of one-person train crews. There was at that time relatively little interest in and little thought given to observing individuals within the crowd (Butcher 1990). By the 1980s, crime on the LU had become a political issue just as it had in large cities in the United States and Canada. Added to the concerns were fears of Irish Republican Army bombings, which eventually included the deaths of three people on the rail system, one at Victoria Station in 1991 and two on the Docklands Light Railway in 1996.

Despite this prevailing fear of terrorism, the primary purpose of the LU surveillance video network was to continue its original purpose, namely to alert staff to dangerous build-ups of passengers at escalators and other strategic points, not to catch criminals. Any thoughts of catching criminals were limited to the view that if station staff observed a crime, they would call police or use the public address system to intervene by vocally drawing attention to the crime.

#### **Fennell Report on the King's Cross Station Fire**

The vast expansion of surveillance equipment in the LU came not because of fears of terrorist attack or of crime, but as a direct result of a massive fire at King's Cross Station in November 1987, the same station that was the scene of the July 7 bombing. The fire started in one of the station's four escalators and spread throughout the ticket hall and the station within minutes at the end of the evening rush hour, resulting in 31 fatalities, including 1 employee. Because of the chaotic conditions and the lack of an emergency evacuation plan, the number of injuries was never tallied. The fire spread rapidly owing to the draft created by the train movements, the steep incline of the escalators, and the station itself, including its design and the existence of old paint on the walls that burned quickly.

The post-incident investigation report, commonly referred to as the Fennell Report after its chair, Desmond Fennell, led to changes in fire standards. The report also highlighted the absence of interoperable communications, firefighters' lack of knowledge of the station, the station's general lack of cleanliness and its low maintenance standards, and the lack of emergency access/egress policies. All these are today considered standard features of emergency management plans (*Making Transportation Tunnels Safe and Secure* 2006, pp. 39–42). Finally, the report noted that transit systems had introduced video surveillance that in addition to proving effective in reducing crime, allowed better control of stations primarily to deal with the specific dangers presented by crowding and fires (Butcher 1990).

Video surveillance cameras in the LU continue to serve the dual functions of operations management and crime prevention. One system is used primarily for its original purpose of managing and operating patron flow and ensuring, for instance, that doors clear the platforms. The second system, which includes recording capabilities, is used primarily for law enforcement purposes, with images fed to a central location under police control (Loukaitou-Sideris et al. 2006, p. 737).

The use of video surveillance throughout the United Kingdom, not only on transit but also in parking lots, town centers (downtowns or shopping districts), and entertainment areas, particularly where there are taverns that attract young patrons, has received considerably more attention than in the United States. In the face of a number of academic studies that drew few definitive conclusions, in 2007 the *London Evening Standard* compared surveillance cameras in different parts of London, including the transit system, and claimed that police were “no more likely to catch offenders in areas with hundreds of cameras than in those with hardly any.” This was despite expenditures of more than £200 million (about \$294 million in 2010) (Davenport 2007).

In the face of recent criticism of the widespread reliance on surveillance throughout the country, in May 2010 the Conservative–Liberal Democrat coalition government announced that curbs would be placed on the “tens of thousands of closed-circuit television cameras in public areas” owing to their “little impact on crime rates over the years.” The new deputy prime minister, Nick Clegg, noted that it was “outrageous that decent, law-abiding citizens get treated as if they have got something to hide” (Burns May 20, 2010, p. A6). But within slightly more than a fortnight of the announcement, police claimed to have solved a major crime after viewing images from security cameras outside the home of a suspect who was charged with having killed a woman who was visible on the camera, one of a number of women he is believed to have slain (Burns May 28, 2010, p. A4).

## USE OF SURVEILLANCE BY TRANSIT SYSTEMS WORLDWIDE

Despite the focus on recent acts of terrorism against rail networks, rail-directed terrorism has a long international history. Among the attacks on the Italian rail network was one outside Bologna in 1974 that killed 12 people and injured 48; another in 1980 at the Bologna station that killed 40 people and injured almost 300; and one in 1986, also in the Bologna area that killed 12 people and injured almost 200. In 1986, Chile saw 78 explosive-related incidents on its rail system. Two subway bombings occurred in Paris in 1995, including one in July on a commuter rail train entering the underground Saint-Michel station during rush hour that killed 7 people and injured 80 when the explosion led to a fireball that measured over 3,000°C at its epicenter. A second Paris bombing occurred only 3 months later at the Orsay Museum station. Attributed to the Armed Islamic Group, it resulted in no deaths but more than two dozen injuries. In May 2010, this event received renewed publicity when French police arrested 14 men they suspected of plotting the escape from prison of one of the bombers. In Argentina, in 2008, commuters set fire to a train that had delayed their morning commute in what officials believed was sabotage by leftist political activists. A similar incident involving commuters had occurred at the main railway station a year earlier. Bus bombings have been frequent throughout Israel, including in its two major cities of Tel Aviv and Jerusalem, where suicide bombers often targeted bus stations and shelters in addition to the vehicles themselves, particularly after it became more difficult for them to enter the buses unobserved.

### Nerve Gas Becomes a New Terrorist Tactic

The Kasumigaseki subway station in Tokyo, Japan, was the scene of a nerve gas attack carried out by the Aum Shinrikyo religious sect when members of the group released five canisters of diluted sarin, an extremely toxic chemical, disguised in lunch boxes and soft drinks on five separate subway trains during the morning rush hour. Although only 12 people died, between 5,000 and 6,000 were exposed to the sarin gas. This is an example of the vulnerability of transit systems even when they are not the primary target, as the cult members released the gas on these particular trains not with the aim of killing transit passengers, but of causing deaths in police headquarters and other government buildings in the area immediately above the stations.

Unlike many countries in Europe where transit security is a national issue, but like the United States and Canada where planning tends to be localized, the Japanese government provides guidance to transit operators on security issues that are recommendations rather than regulations. In response to the attack, both the Tokyo Metro and the Toei Subway added patrols by both their own staffs and private security officers and installed more than 2,000 video surveillance cameras.

Similar to U.S. crime prevention strategies, signs were also posted in stations and on railcars, and announcements were added reminding passengers to report suspicious persons and objects. In addition, trash cans were removed from all public areas, as is true in many U.S. transit systems today.

The King's Cross fire and the Tokyo sarin attack highlight the importance of train control, which today is often video-assisted. In King's Cross, the fire was fueled by drafts caused by the failure to halt train movements. In Tokyo, the sarin was carried from station to station by moving trains and doors continuing to open as the trains moved through the stations.



FIGURE 1 This is an example of a reminder to passengers. Deutsche Bahn posts signs on its buses and railcars reminding patrons of its 24-hour hotline for reporting vandalism; many portions of the system are also under video surveillance. Photo courtesy of Dorothy M. Schulz.

### Learning from One Another

A transit system following ideas and plans established by others is common. Just as the Tokyo Metro turned to tactics used by a number of U.S. systems, in mid-May 2010, Prague, the capital of the Czech Republic, announced that the sensor and camera system it began planning for in the wake of the Tokyo attacks would be operational within 2 weeks. The city's public transport company announced that in addition to surveillance cameras, the system would include sensors that can detect leakages and send information to the operations center and to police and would automatically activate instructions to passengers to assist in evacuations ("Prague deploys sensors..." 2010). This, too, follows actions taken in the United States, where a number of systems have installed sensors to fulfill a variety of roles.

Whether for passenger or risk management, crime prevention, or terrorism concerns, many countries have turned to video surveillance in their transit systems. In New South Wales, Australia, CityRail introduced cameras in the 1980s; by 1991, cameras blanketed about 25 of its highest-risk stations, including more than 50 cameras at Redfern and almost that many at North Sydney. The installation of the cameras was highly publicized. Rail staff believed that the cameras had reduced assaults in the stations as well as graffiti activity, but researchers found this difficult to confirm because the installation of the cameras was accompanied by an increase in security officers (Easteal and Wilson 1991, pp. 19–20).

In 1985, when Hong Kong extended its 6-year-old Mass Transit Railway (MTR) by opening the 12-station Hong Kong Island Line, surveillance played a major role in its protection plans even though the new line was a change from single-level stations to some as many as seven levels deep. Here, too, researchers have been reluctant to attribute the low crime rate on the railway solely to the cameras. The transit system is policed by a unit of the Royal Hong Kong Police Department. Response times to incidents observed on the monitors have been described as "an almost miraculous 60 seconds—maximum—on a station, or two and a half minutes if the officer has to come by train from another station" (*The Police Journal* 1985, pp. 265–266). As with WMATA and MARTA, the MTR incorporates many features of CPTED; stations are well-lit and built without blind spots or niches, and there are no public toilets, luggage lockers, or food stalls. This assists those who monitor the video cameras by minimizing the reasons anyone might be observed doing anything but waiting for a train or exiting a train (see Figure 1).

Concerned about graffiti, public order, and more serious crimes on its transit system in the mid-1990s, the Dutch Ministry of Transport added surveillance cameras to its buses but relied on enhanced human security on its rail lines. Rail officials tried to address the unemployment problem and the need for extra security by recruiting unemployed men as watchmen. Although they lacked police authority and did not carry weapons or handcuffs, the men patrolled stations to act as deterrents to miscreants. Surveillance observations on the buses found that most problems involved aggressive youths who frightened regular patrons, resulting in most of the youths being referred to their schools for handling (Smeets and Jacobs 1996, pp. 32–33).

The Tri-County Metropolitan Transit District (Tri-Met) in Portland, Oregon, introduced a similar citizen-based program decades ago. A Rider Advocate group, consisting of a supervisor and ten people recruited from a nonprofit neighborhood coalition, randomly rode buses that had a high rate of gang-related incidents; they were paid and identified with Tri-Met through their jackets and patches. The program, which currently operates in partnership with Victory Outreach Community Services, was initially expanded as part of the AmeriCorps program to include college-age community residents who received stipends and tuition benefits in return for their participation. All advocates are selected and work in accordance with Tri-Met's guidelines.

France also has a lengthy history of terrorist activity. Between 1970 and 1995, terrorists carried out more than 20 attacks on French surface transportation systems (Fink 2003, p. 1822). The Paris Transport Authority (Régie Autonome des Transports Parisiens or RAPT), the agency that oversees Métro, bus, and tramway service in and around Paris, tended in the 1980s to view its communications and surveillance networks as parts of its station management and fire preven-

tion programs rather than as crime or terrorist prevention tools. The system's fire prevention tactics in 1989 included station telephones linked to RAPT headquarters and the fire brigade, with surveillance cameras allowing staff to monitor public areas as well as the system's electrical and mechanical plant (Simony and Loesche 1989). More recently, Camille Fink (2003) described RAPT as having enhanced security that now includes physical barriers, alarm systems, and a surveillance network that relies on software to allow operators to bring up a particular image from any one of more than 4,000 cameras.

In a study of *Météor* (Métro Est-Ouest Rapide), a line developed to provide service to Paris' northern and southern suburbs, Marina L. Myhre and Fabien Rosso (1996) compared it to WMATA as it, too, was planned to allay passengers' fears of crime and disorder by designing in CPTED elements. In contrast to most of the existing stations on the 13 Paris Métro lines, where stations had multiple entrance/exits and long, winding corridors, and lacked surveillance cameras, *Météor* was designed to include two surveillance cameras at platform ends and onboard cameras linked to a systemwide control center. In addition to surveillance cameras, *Météor* relies on a number of other security features similar to U.S. systems. As with WMATA, uniformed and plainclothes attendants are present in the stations and are equipped with two-way radios to communicate with police and, as MARTA, a variety of intercoms, call buttons, and emergency alarms enable the command center to communicate with operators and passengers through the public address system (Loukaitou-Sideris et al. 2006, p. 732). These features can be found on MARTA and on a number of newer U.S. light rail systems but are more difficult to install and maintain on older systems, where either the technical capacity is lacking or where vandalism results in high malfunction rates.

Spain has also witnessed considerable terrorist activity, primarily at the hands of the Basque independence organization, ETA, which was initially suspected of having caused the March 11, 2004, attack on Renfe, the national rail system, before it was determined to have been carried out by al Qaeda operatives. Although municipal police protect Metro Madrid, Renfe has its own police force; the two share responsibility for both crime prevention and response to crimes. Since the attacks, stations have been retrofitted with anti-intrusion and detection systems, and additional surveillance cameras and private security officers are now employed to monitor patron and employee areas (Loukaitou-Sideris et al. 2006, p. 740).

In 1998, responding primarily to patron reports of feelings of insecurity and to damage to equipment caused by vandalism, the Italian railway system developed a command and control system to centrally manage railway operations that included a surveillance system. Nino Ronetti and Carlo Dambra (2000)

described the surveillance system as serving a number of purposes, including control of patron traffic patterns, passenger safety, management of emergencies and crises, and remote observation of unprotected areas. The central control room included real-time monitoring of the surveillance images by civilian personnel, who were able to make announcements to patrons with a public address system. They were also able to remotely configure the system's functions to focus on particular areas or images. In addition to monitoring patron areas, cameras were also installed to view yards and storage areas.

#### **Watching Now or Watching Later**

Throughout this synthesis, viewing in real time is defined as someone watching the monitors with the capability of making public address announcements, dispatching agency police or emergency personnel to the location, or contacting local emergency responders. Response could be to crimes in progress, patron calls for assistance, safety-related matters, or rail operations activities that require immediate response. Not all cameras are viewed in real time; those that are not are used for retroactive or forensic investigation by police officers. In these instances, the images are used to assist in investigation of events that have already occurred but that the transit agency or other authorities have determined require follow-up activity. Examples could be crimes, safety hazards, accidents, or derailments.

A U.S. Government Accountability Office (GAO) report released in 2006 on passenger rail security found that five countries that were not identified had centralized the process for performing research and developing passenger rail security technologies as well as for maintaining a clearinghouse on technology and best practices. The report noted that U.S. rail agencies interviewed for the study expressed an interest in a more active centralized research and development authority (Hecker 2006, p. 15). Recently, alluding to this greater level of centralization, Amtrak Vice President and Chief of Police John O'Connor told members of the Senate Committee on Commerce, Science, and Transportation that Amtrak had become the first American rail police department to become an associate member of RAILPOL, a European organization of rail and transit security agencies that were cooperating to share intelligence, coordinate activities, and improve counter-terror capabilities (O'Connor 2010, p. 4).

#### **Estimating the Number of Cameras**

Although video surveillance has proliferated as a law enforcement tool in the United States, its use is far more common throughout Europe and Asia. A review of rail security measures in 2007 found that almost all European Union countries that had not previously installed surveillance equipment on their rail systems had done so in the aftermath of terrorist activities, including, for instance, the installation of 1,500 security cameras to guard the Belgian

rail service and the installation of 1,200 security cameras to guard Swedish subway and commuter rail stations (Howarth 2007). One vendor put the number of cameras at 2.75 million in China, 4.2 million in the United Kingdom, and 30 million in the United States and estimated that the global market was worth \$13 billion in 2009 and could be worth \$41 billion by 2014 (Ben-Zvi 2009). But vendor estimates might be taken with a grain of salt, particularly because periodic reports indicate that even in countries where law enforcement is more centralized than in the United States, the actual number of surveillance cameras is difficult to calculate.

### **USE OF VIDEO SURVEILLANCE BY CANADIAN TRANSIT SYSTEMS**

Rarely have transit studies played as pivotal a role in theories of crime than in those pertaining to fear of crime. One of the earliest and most important of such studies was conducted by the Toronto Transit Commission (TTC) in 1976. Responding to the concerns of the Metro Action Committee on Public Violence Against Women and Children (METRAC) and the Metro Toronto Police Force, the TTC undertook a safety audit, which documented that despite a low crime rate, the subway system was perceived as unsafe by many women.

The study, *Moving Forward: Making Transit Safer for Women* (1989), for the first time formally recognized the much higher levels of fear expressed by women patrons of public transit. The study stemmed from a safety audit that established that women feared sexual assault on the Toronto transit system despite its low crime rate. Women, who had not previously been asked such questions, admitted that their fears caused them to limit their use of transit altogether or during nighttime hours. To address these fears, features were added to the transit system that are today taken for granted, including installing passenger assistance alarms in transit vehicles, installing emergency telephones on platforms, closing off dead-end passageways, creating visibly marked off-hours waiting areas, and creating large and easily understood signage.

In responding to *Moving Forward*, the TTC turned to video surveillance as a crime prevention and fear alleviation tool. This tactic has become common throughout Canada, where passenger rail systems rely heavily on video surveillance. Many of these agencies provide considerable detail about their safety and security strategies on their websites, including more open discussion of the presence of surveillance than is found on U.S. transit agency websites.

Just as in the United States, residents of major Canadian cities and their suburbs depend on rail transit for travel to and from their central business districts. According to the Canadian Urban Transport Association, in 2007 public transit employed 45,000 people and had a 1.7 billion total rid-

ership (Issue Paper 23, June 2007). The same report noted the prevalence of video surveillance technology both inside stations and onboard vehicles and also noted that in response to citizens' desire for greater levels of protection, a number of transit systems, including Greater Vancouver, Toronto, and Ottawa, have increased the legal powers of their security personnel, including broadening powers of arrest and authorizing officers to enforce the Criminal Code as well as laws relating to trespassing, liquor licensing, and controlled substances violations (Issue Paper 23, June 2007). The policing configurations of Canadian transit agencies are not unlike the United States in that officers range from those who have full police authority to those who are basically security officers.

In the aftermath of the 2001 terrorist attacks, the Canadian federal government assumed a larger role in transit security both financially and through regulations that require agencies to conduct risk assessments, outline mitigation strategies, and develop systemwide security plans. For instance, the Transit-Secure Program set aside \$80 million CAD (Canadian dollars) to support security measures by urban transit (bus) and passenger rail operators. The first round of funding, which was announced at the end of 2006, included up to CAD\$37 million to help transit systems in Canada's six major metropolitan areas (Vancouver, Edmonton, Calgary, Toronto, Ottawa-Gatineau, and Montreal) conduct risk assessments; develop security plans; create employee training and public awareness programs; and upgrade security equipment such as surveillance equipment, access control technology, and lighting. The second round of Transit-Secure funding, announced in 2007, included up to CAD\$2 million to support risk assessments and comprehensive security planning by smaller communities that rely on bus rather than rail service.

Transport Canada, Public Safety Canada, and local stakeholders have sponsored a number of emergency preparedness activities, particularly in the interjurisdictional areas that include Vancouver, Toronto, and Montreal. These activities, which include tabletop, command post, and full-scale live exercises and drills, are sponsored to help government officials, transit system personnel, first responders, and law enforcement agencies prepare for their emergency roles.

### **Toronto Transit Commission**

The TTC, the largest transit system in Canada, carried 445 million passengers on 2,500 vehicles in 2006. Based on a review of antiterrorism security weaknesses that identified a number of potential mitigation measures in 2006, TTC was awarded CAD\$1.5 million in Transit-Secure funding to support a terrorism-specific risk and vulnerability assessment, enhance property security and access controls, and install a surface vehicle broadcast messaging system. Future initiatives could include enhanced visual monitoring technology for subway stations and high-risk surface vehicle routes (Issue Paper 23, June 2007).

In addition, in October 2007, the TTC announced plans to install nearly 12,000 surveillance cameras on its entire fleet of buses, streetcars, and on all new subway cars and also at all rail and bus stations. The system was planned for real-time viewing as well as having the capability to download video to a central archive for investigations of past crimes. Streetcars were expected to be outfitted with between four and six cameras each and plans called for the nearly 250 new subway cars to each have one camera. No decision had been made on whether the existing 800 subway cars would be retrofitted (Edwards 2007). The new cars, manufactured by Bombardier Transportation, also include a two-way intercom system for drivers and passengers to communicate, and the cars can be delivered with integrated communications for passengers for alerts such as which doors will open and which stations are being approached.

### **Ottawa O-Train**

Ottawa's LRT service is Canada's newest and smallest rail transit system. Opened in 2001, the O-Train travels for about 5 miles, carrying about 10,000 passengers daily. Unlike many LRT systems, its alignment is entirely isolated from road traffic but the lightly-used Ottawa Central provides infrequent freight traffic on pre-existing Canadian Pacific Railway track after the O-Train's operating hours.

Operated by OC Transpo under its official name of Capital Railway, the system is considered light rail in part because of extension plans into downtown Ottawa and in part because its railcars are smaller and lighter than most in North America and do not meet Association of American Railroads' standards for crash-worthiness for mainline train cars. The railcars use one operator and no additional crew. The three diesel-powered Talent railcars, built by Bombardier as part of a larger order for Deutsche Bahn's regional network, run on 15-minute headways. Five stations are monitored by surveillance cameras and their images are observed by communications officers. These officers also answer emergency calls and dispatch the Transit Special Constables, who are supported by members of the Ottawa Police Service for problems they are not authorized or trained to handle.

### **Montreal Metro**

Montreal is served by two transit agencies. The Montreal Metro is a 71-km (about 44 miles) subway system operated by the Société de transport de Montréal (STM) that currently comprises 67 stations on four separate lines. The Agence métropolitaine de transport operates the 214-km (about 133 miles) rail agency that provides service on five commuter rail lines in addition to operating a bus network. The Metro is Canada's longest subway system and the busiest in terms of daily passengers (987,000 on an average weekday in 2008, when more than 290 million riders used the system). Neither the subway's nor the commuter rail line's websites, whether

in French or in English, provide the same level of detail on safety and security arrangements as those of the other Canadian transit agencies.

Because the Metro's rubber-tire subway cars are among the oldest currently in use, dating back to the mid-1960s, and are not air-conditioned, it is likely that no video surveillance system exists on the cars, which also do not permit passengers to move between cars once onboard. Even the newer cars date from 1976, before rail vehicle manufacturers delivered equipment with pre-installed surveillance systems. Requests for proposals for bids in 2008, though, specified that vehicles include larger windows, additional lighting, high-definition televisions, a new public address system, and surveillance cameras. More recently, in October 2010, the STM signed a contract for 468 rail vehicles meeting its specifications ("STM contract signing..." Oct. 22, 2010).

In late 2007, Metro announced that it would use CAD\$3.6 million of the CAD\$5.7 million that the Montreal region had obtained from the Transit-Secure program to add 240 video cameras to the 1,200 already in place. An additional CAD\$75,000 would be used to improve the reliability of video surveillance equipment at Montreal's downtown Central Station. Cameras would be located in areas identified in a study based specifically on terrorism-related security issues ("Cash to Secure..." 2007).

### **Alberta Transit Systems**

The province of Alberta is home to two of Canada's passenger rail systems, the Calgary Transit Authority and the Edmonton Transit System. Both provide considerable detail on their websites about their service and their safety and security policies and advise readers that the collection of recorded camera images is authorized under Section 33c of the Freedom of Information and Protection of Privacy Act.

Edmonton's light rail system is a 21 km (about 13 miles), 15-station system operating 74 LRVs that carry more than 74,000 passengers on an average day. Average speed is 70 km per hour (kp/h) [about 44 miles per hour (mph)], and headways are 5 minutes during peak hours. All stations and major transit centers feature surveillance cameras that are linked into an emergency telephone network that is activated as soon as the help phone is engaged and also allows an officer in the control room to speak with the patron over the phone. Safety and Security Division personnel are also able to monitor incidents through a computer-aided dispatch system in patrol vehicles. This system allows officers to receive information from control center staff viewing the surveillance monitors. Transit officers are designated as special constables, which authorizes them to enforce transit laws and to carry batons and pepper spray. Funds for ongoing enhancements to lighting, to improve CPTED design features in and around stations, and to improve the

existing surveillance system were provided by the Transit-Secure Program.

All Calgary Transit (locally referred to as CTrain) stations and platforms are under 24-hour surveillance by more than 350-cameras located throughout the system. Stations and platforms are also equipped with emergency telephones (called HELP phones in Calgary). Video monitors are viewed by staff members who have the ability to contact the system's uniformed peace officers. In 2008, following a murder of a woman who was stalked aboard a train and followed home, Calgary Transit doubled its staff of peace officers to 65. Although the officers do not have full police powers, they are authorized to enforce a number of municipal bylaws (Stelter 2009). Similar to a number of states in the United States, the major difference between peace officers and police officers is that peace officers cannot conduct investigations but may take actions for a limited number of situations that occur in their presence; they also receive fewer hours of training. Also in 2008, with funds provided through the Transit-Secure Program, Calgary installed a dozen pan-tilt-zoom cameras at selected locations to provide improved surveillance capabilities. A parking fee was also instituted to generate funds dedicated to enhancing the safety, security, and cleanliness of the transit system.

#### **British Columbia TransLink**

The Greater Vancouver Transportation Authority (TransLink) is a complex transit system that has come to rely heavily on video surveillance, particularly since the Winter Olympics in 2010. Because the system spreads out from the city itself, TransLink covers the largest geographic area of any North American transit system. It comprises more than 1,000 square miles (1,800 square kilometers), travels through 17 municipalities, and in 2007 served more than 165 million passengers. SkyTrain, a subsidiary of SkyLink, is a fully automated, 49.5 km (about 31 miles) light rail system with 33 stations that links downtown Vancouver with a number of its larger residential suburbs. Built in 1986 to serve the World's Fair held in Vancouver, it is the longest automated light rail system in the world. Like a number of the newer light rail systems, SkyTrain included a surveillance system when it began revenue operations. When the system was expanded in 2000, the IT network was upgraded to expand beyond the 850 analog cameras that recorded around the clock, with feeds sent from each station to a central control center where images were recorded and stored.

Similar to the synthesis case study involving Metro Transit in Minneapolis, Minnesota (see chapter five), experiences in British Columbia reinforce that even a modern surveillance system requires frequent upgrading. By 2005, the network was not considered large enough to handle the amount of video that was being generated (Anderson 2008). Almost CAD\$10 million of Transit-Secure funds distributed in 2006

went toward the most recent upgrading of the system, which also included funds for enhanced lighting and helped to pay for retrofitting that was in progress when the funds were distributed. With the system introduced in 2008, cameras are able to transmit three video feeds per station—the inbound and outbound platforms and the lobby. The project is labor intensive; 6 employees administer it, including managing who may access the system, and 18 employees were trained in system maintenance.

Just as it has consistently upgraded its surveillance camera network, TransLink has seen a need to upgrade its human security network. Although SkyTrain initially was patrolled by Transit Special Constables, in December 2005 TransLink created the South Coast BC Transportation Authority Police Service to allow officers to pursue a suspect outside the transit agency's property and to coordinate their activities more fully with local police.

#### **VIDEO SURVEILLANCE AND PUBLIC PERCEPTIONS OF SAFETY AND SECURITY**

The TTC/METRAC study was in the forefront of research that determined that the public's perception of whether transit facilities are safe can affect decisions that will impact ridership. This is particularly true in parts of the country where the decision to use public transportation or to drive is a discretionary one. Many riders of the nation's largest transit systems may have few other commuting options as a result of traffic congestion and the inadequate parking facilities in the central business districts, but in other parts of the country the decision to use the transit system is based on a number of factors. Research has shown that safety and security play a large role in the decision, particularly for women.

Today, the TTC/METRAC finding that women are more fearful of crime than men is commonly accepted by researchers and police executives. Related findings by Margaret T. Gordon and Stephanie Riger (1989) were explained by criminological theories discussed by Dorothy M. Schulz and Susan Gilbert (1996) at the FHWA's second national conference on women's travel issues and more recently by Anastasia Loukaitou-Sideris, Amanda Bornstein, Camille Fink, Linda Samuels, and Shanin Gerami (2009). These theories of crime and fear have influenced decisions by transit systems on a number of security measures, including enhanced use of video surveillance systems.

Opportunity theory, advanced in the late 1970s by Lawrence E. Cohen and Marvin Felson (1979), stated that offenders will commit crimes where there are suitable targets and an absence of protection. This theory played a large role in the expansion of CPTED as a way to use the physical facility itself to create a more protected environment. Derek B. Cornish and Ronald V. Clarke (1986) extended

the theory by introducing the concept of “rational choice,” which stated that offenders are rational, self-serving individuals who will weigh the benefits and risks of committing a crime in a particular place at a particular time. The benefits of a particular location are the presence of a victim and the ability to commit a criminal act and escape unseen. The risks include being observed or being unable to escape. Many patrons view transit as providing a number of the benefits criminals consider. Specifically, the patrons view themselves as available victims and they view the transit system itself as providing hiding places. Because they may not see a police presence, they estimate the possibility of the capture of their victimizer as low. Unfortunately, criminals may see the same cost-benefit analysis and act accordingly. But electronic video surveillance systems change the equation. They increase the risk of being observed; an offender might be observed and actually caught before fleeing, or his or her image may be caught to use for retroactive investigation and subsequent arrest.

### **Women and the Fear of Victimization**

Women’s higher fears of victimization are based on their generally facing higher levels of stranger violence (Young 1992), and according to Richard B. Felson (1996) their fears are generally correct. Because they are often smaller than their aggressor might be, they are more likely to be the targets of random violence in public spaces. Women interviewed by Loukaitus-Sideris and colleagues as part of an MTI study on easing women’s fears of transportation environments (2009) found that women believed that as a group they had distinct safety/security needs and that despite improvements in transit security, they were often fearful of transit settings. Echoing the earlier TTC/METRAC findings, these fears often led women to adjust their behavior and travel patterns and/or avoid certain travel modes and settings at certain times. For transit agencies, this translates into lost revenue. But despite this finding, the MTI researchers also found that only a small number of U.S. transit agencies had programs that targeted the safety and security needs of women riders. Although most systems agreed that women had distinct safety and security needs, only a third of those surveyed believed that agencies should put specific programs into place to address these needs.

Jerome A. Needle and Renée M. Cobb in a TCRP study entitled *Improving Transit Security* (1997) found that fear and anxiety about personal security were important detractors from using public transit for all potential patrons, not only women. Although gender has emerged as the most significant factor related to fear of crime and victimization in transit environments, other studies, not all conducted in the United States, have found that fears are also more pronounced among the elderly, certain ethnic groups, and low-income people, who typically live in high-crime neighborhoods and may see their local transit station

as reflecting the crime and disorder in the neighborhood (Loukaitus-Sideris et al. 2009). These groups are often the most transit dependent because they lack access to a private vehicle.

### **Preventing “Broken Windows”**

These findings on fear of transit crime support a more general theory of crime prevention that applies not only to women but to all potential transit patrons. This so-called broken windows theory, popularized by criminologists James Q. Wilson and George Kelling (1982), posits that a broken window that is not repaired sends a message that a facility is uncared for and thereby presents a target for disorderly or criminal behavior. In this theory, any sign of neglect, such as graffiti or scratchiti, or even an overflowing trash bin, has the same effect.

In addition, Wilson and Kelling theorized that disorder creates fear in those who live nearby or must use those facilities and that the areas eventually attract sex-traders, drug addicts, and noisy youths who make the facility even less desirable to others. When those who are unable to shun the facility make use of it, they, too, begin to contribute to its disorder; they believe there is little chance their behavior will be penalized because there appears to be no responsible authority over the location. This is part of the reason to make public address announcements reminding patrons of the consequences of even modest misconduct. It sends a message to all in hearing distance that the location is being monitored and that someone is in charge and is responsible. Even with announcements, a facility may have reached such a state of neglect that it may require not only CPTED redesign but also uniformed patrol presence until it is restored to an orderly condition. Once order is re-established, visible video surveillance with appropriate signage indicating its presence and public address announcements reinforcing this signage can help assuring patrons that a certain level of safety, security, and orderliness has been established and will be maintained.

Transit agencies’ efforts to redesign stations to allay these fears and, particularly since September 11, 2001, to add video surveillance systems to public areas have addressed some but not all of these fears. Studies in Nottingham, England, and Ann Arbor, Michigan, found that patrons felt only moderately safer with the knowledge that cameras were watching. In England, focus groups composed of women stated that they did not feel more secure knowing that “someone, somewhere is supposed to be watching them” (Trench et al. 1992), and the Michigan study found that although surveillance cameras were the most noticed of the security improvements implemented, they did not have a significant impact on passengers’ feelings of safety (Wallace et al. 1999). Yet because so many of the studies in the United Kingdom and the United States

are based on small samples or individual locations, the true effect video surveillance has on patron perception of security is difficult to determine. Despite this unanswered

question, electronic video surveillance has come to predominate in crime and terrorist prevention efforts around the world.

## HOW TRANSIT AGENCIES USE VIDEO SURVEILLANCE

### INTRODUCTION

The number of passenger rail transit systems has increased considerably within the past decade as new systems, particularly light rail operations, have initiated service in a number of cities. Today, passenger rail covers a wide range of agencies, from those operating fewer than a dozen streetcars during the morning and evening rush hours to those running hundreds of trains for 20 or more hours a day. In addition to the number of vehicles and distances traveled, the systems differ in their operating environments and in their organizational and jurisdictional arrangements.

To undertake a comprehensive study, it is important to survey as many agencies as possible that operate a passenger rail system so that all systems, regardless of size and complexity, may use the experiences of others to help them make decisions that fit their needs and pocketbooks. In an ideal world, everyone can learn from everyone else, but a new southwestern light rail system would learn fewer lessons from a northeastern heavy or commuter rail system than from another light rail system regardless of location.

To reach the largest possible number of transit agencies, a one-page letter from TRB and a four-page survey instrument were emailed to 58 agencies (a copy is provided as appendix A). Information was received from 43 agencies (listed in appendix B). In addition to reflecting a high rate of return for the survey questionnaire (73%), the agencies were located in all parts of the United States. They reflected all modes of passenger transit service (heavy, commuter, and light rail) and included old and new transit systems, including those that do not anticipate entering revenue service for at least another year or two. The findings may, therefore, be considered to embody both agency practices and those of the nation's passenger rail systems.

Several large transit systems were sent a single questionnaire, even though they are multimodal agencies that operate two or more transit modes. Although each agency was asked to identify itself and to include the name and title of the person who completed the questionnaire, each was promised anonymity unless it granted permission to be named; hence statistical information does not identify the agencies. Even with this promise, one agency refused to participate based on its belief that the information was too sensitive to make

available, and a large, multimodal agency on the East Coast, declined to participate owing to ongoing litigation involving its surveillance system provider.

The questionnaire responses were tabulated by the study's authors and reviewed with transit specialists. Any discrepancies or apparent misunderstandings were resolved through telephone calls or emails to the agency representative who completed the survey. Each of the agencies that responded used electronic video surveillance in some way. Agencies that did not employ surveillance could complete the questionnaire; none did. The agencies that declined to cooperate also use video surveillance. Yet, because not all agencies responded, the study cannot state without question that all transit agencies use some form of video surveillance. Although there seems to be overwhelming use of it, how extensive the use might be continues to be open to question.

The period of initial introduction of video surveillance capabilities stretched from the 1970s to within the past few years. This also reflects the differing ages of the transit agencies themselves. A number of newer systems have included video surveillance in their operations since the introduction of revenue service. The agencies that replied each used video surveillance for a variety of functions. Agencies were provided ten common areas where video surveillance is most often employed; all correctly understood this to mean locations on which cameras were focused.

Regardless of when it was installed, agencies use surveillance for many purposes and in many areas. The largest number of agencies (40) employed electronic video surveillance in stations, and on station platforms and shelters, followed by passenger areas onboard railcars (33). Table 1 indicates where agencies are using video surveillance cameras.

Note that as with all synthesis tables, not all agencies answered all questions; for this reason, actual numbers rather than percentages are provided. Because not all responders interpreted all questions identically, there are a small number of discrepancies in some totals. Owing to the number of respondents, none of these inconsistencies were considered to have skewed the data and therefore were retained as submitted.

TABLE 1  
WHERE ELECTRONIC VIDEO SURVEILLANCE IS USED

Where	No.
Onboard Vehicles	
In passenger areas	33
In operator/cab area	11
Stations, Station Platforms, Shelters	40
Elevators Only	10
Parking Facilities	28
Along the ROW	11
In Storage/Other Yards	26
In Employee/Administrative Areas	20
Other	8

### STATIONS, STATION PLATFORMS, AND SHELTERS

As indicated, the largest locations for electronic video surveillance were stations, station platforms, and shelters. Forty agencies said they used cameras to observe these areas. Ten agencies reported that they employed surveillance only in elevators, but this information contradicted their other replies. Considering the totality of responses, it appears that no agencies employ surveillance only in elevators and that cameras in elevators are part of the overall placement of cameras elsewhere in stations, station platforms, and shelters or parking facilities.

Although the most common use of video technology is to observe stations, station platforms, and shelters (which may or may not include elevators), the percentages of such passenger areas covered by surveillance differed greatly. Using categories of under 25%, 25% to 50%, 51% to 75%, and 76% or more, the findings indicated that the newer the transit agency, the more likely that all stations, station platforms, and shelters were observed by video cameras as part of overall crime prevention efforts (Table 2). Each of the 40 agencies reported the percentage of its stations, station platforms, and shelters that were covered by its video surveillance systems. Because a number of systems were multimodal, the percentages are not broken down by mode, but newer rail systems (which are often all or primarily light rail systems) tended to fall in the highest category.

TABLE 2  
PERCENTAGE OF STATIONS, STATION PLATFORMS, AND SHELTERS MONITORED BY VIDEO SURVEILLANCE

Category	No.
Less than 25%	8
26–50%	4
51–75%	8
76–100%	20

Among older, heavy rail systems, both WMATA and MARTA have had surveillance capabilities at all their stations since their inception. However, surveillance systems are not static and need to be upgraded over time. In 2009, for instance, WMATA announced that it would upgrade its cameras on buses, in ventilation shafts, at station entrances, and near the ends of platforms by using funding that included a DHS grant of almost \$28 million. Of the total amount, about \$7 million was set aside to add surveillance inside railcars, in part because the agency viewed the improvements primarily for crowd control even though most of the money came from security grants (Harwood 2009).

An older system that added cameras well after its initial operations was Massachusetts Bay Transportation Authority (MBTA, known locally as the T). According to TCRP's *Transit Security Update*, MBTA, a multimodal system, installed cameras in all subway stations in conjunction with its installation of automatic fare collection equipment (Nakanishi 2009). Although the T began to install cameras around 2000, in 2002 it began to upgrade to a fiber-optic network funded in part by \$23 million from DHS. The higher resolution provided by the new cameras resulted in positive media attention when a man accused of robbing a passenger at gunpoint at the busy Back Bay station was identified based on a description that included a tattoo that matched a surveillance image of the man entering the station at about the time of the robbery (Daniel and Smalley 2007). Currently, more than 500 cameras have been installed in T stations and in trains; they are monitored in real time at a number of locations by both police department and rail operations personnel. At least some of the cameras will rely on analytic software ("smart" video) to identify suspicious behaviors and/or objects. MBTA notifies patrons that cameras are in use.

In Portland, Oregon, Tri-Met video cameras monitor shelters and stations in the Portland Mall area, known locally as the transit mall. The installation, part of a 2-year improvement plan in conjunction with the MAX Green Line, added to a network of cameras that covers most stations and all parking garages and elevators. Another light rail system that had earlier benefited from area-wide improvements, San Diego's Trolley, operated by the Metropolitan Transit System, was able to expand its surveillance network at its C Street Station through a public/private partnership that included the C Street Task Force providing time and material valued at more than \$100,000 toward the installation and operation of eight cameras ("Security Cameras..." 2006).

The Maryland Transit Administration, as part of its overall security and emergency preparedness planning, is adding cameras at those Metro subway stations and platforms that were not included in earlier installations and also in a number of light rail and commuter rail stations. Similar expansion of video surveillance can be observed around the nation; commonly, such announcements are made by the transit agency,

the funding agency, or in some cases the vendor selected to install the surveillance network.

Local media coverage of the expansion of surveillance often includes information about particular crimes or situations where the cameras played a role in apprehension of suspects or in resolution of problems surrounding disorderly behavior, often by teenagers using public transportation to or from school. The Boston case where the forensic evidence provided by the camera resulted in an arrest is typical.

These cases are examples of how the installation of surveillance technology serves a number of overlapping goals. Although DHS funding is primarily based on terrorist-related concerns, once cameras are installed they are likely to assist in fare collection efforts as well as in crime prevention and detection. This is particularly so if they produce images that are sufficiently detailed to provide a basis for post-incident investigation and subsequent prosecution. This type of overlapping function extends beyond transit. In Pittsburgh, Pennsylvania, for instance, a \$2.4 million DHS grant in 2008 that was aimed at protecting the city's waterways, ports, and rivers resulted in Mayor Luke Ravenstahl submitting a federal grant application for funding to install more than 220 cameras to cover nearly all of the city's neighborhoods (Wilkinson 2010). (See the chapter five case study for a discussion of Pittsburgh's surveillance plans.)

Video of patrons' actions may help to mitigate a transit agency's liability by showing the patrons as partially responsible for the event that led to their injury or loss claim. For example, in 2009 in Melbourne, Australia, a 6-month-old boy escaped with only scratches after his baby carriage rolled onto the tracks and was struck by a train that dragged the child about 100 ft before coming to a stop. The mother, who could be seen screaming on the video, had also been seen on the video letting go of the pram just before it rolled onto the tracks (Sweeney 2009). In yet another fall onto rail tracks that received widespread coverage less than a month later, an intoxicated woman was seen falling onto the tracks on Boston's T. Although Boston's video cameras are not linked to an automatic train control system, the woman was not hit because the train driver saw passengers on the platform frantically waving their arms and was able to stop her train in front of the woman, who later admitted to hospital authorities that she had been drinking ("Train Stops Short . . ." 2009).

Video cameras at stations have also captured behavior that has brought bad publicity and most likely added liability to transit agencies and local authorities. Two incidents in 2010 illustrate these unintended consequences. In Portland, Oregon, two city police officers were suspended after their police chief and commissioner indicated they were "troubled" by the officers' handling of a situation that began on the street but was videoed when it moved onto the MAX

light rail system. In this case, the officials found the officers' actions over-zealous; in the other situation, although the security guards did what their job description required their actions were seen as too placid. In Seattle, video showed a 15-year-old girl being beaten by other teenagers in front of three security officers in the Downtown Transit Tunnel. After considerable public outcry, King County Metro announced it would reexamine its policy forbidding its unarmed security guards from physically intervening in criminal or suspicious behavior (Westerman 2010; Stelter Feb. 22, 2010).

One of the most controversial video-based cases did not involve surveillance cameras directly but occurred when a shooting by a BART police officer was photographed by a number of patrons on their cell phones. In that case, in the early morning hours of January 1, 2009, the officer fatally shot a patron on the Fruitville station platform in Oakland, California, following a fight that involved a number of men on the train and spilled out onto the platform. The officer was charged with second-degree murder; as the trial began in June 2010, a number of legal experts predicted that its outcome would provide insight not only into the jury's attitudes toward police brutality, but also into the latest legal thinking on the issues of video evidence (Wood 2010). On July 8, the officer was found guilty of involuntary manslaughter, a lesser charge than the one originally brought against him. In November he was sentenced to 2 years in prison, a verdict that angered the community and resulted in protests in Oakland.

The possibility of this type of surveillance of police behavior has been a concern to police for a number of years. In a review of the pros and cons of surveillance, Ray Surette (2007, p. 155) cited a British study in which nearly one-fourth of police officers queried saw as a major disadvantage of surveillance cameras that they were often the ones under surveillance. The police believed that many low-visibility arrests that previously went unnoticed would now receive supervisory attention and could provide an independent review of their activities that would challenge their version of events internally and possibly in court proceedings.

Although this study referred specifically to police, the use of video surveillance to observe employee behavior is not new and has played a role in managing internal fraud and misconduct of employees for many years. Video surveillance systems provide protections for employees, particularly those working in remote locations at night or on weekends, but their installation is often met with resistance because employees suspect that anything observed on the video is as likely to be used to criticize their activities as to protect them from harm.

Whatever the possible downsides of video surveillance may be perceived to be, responses from agencies as to plans for its use indicate a strong belief in its positive attributes. As Table 3 shows, the vast majority of agencies who answered

this question intend to include plans for video surveillance in all new station designs.

TABLE 3  
DO ALL NEW STATION DESIGNS INCLUDE PLANS FOR VIDEO SURVEILLANCE?

Video Surveillance?	No.
Yes	35
No	3

### ONBOARD RAILCARS

The second most frequent area where surveillance is employed is onboard railcars, an issue that was addressed by three survey questions. Respondents who indicated they used surveillance onboard vehicles were asked to specify whether this was in passenger areas, in the operator/cab area, or in both. They were also asked to indicate what percentage of their vehicles had surveillance devices.

Of the 33 agencies that reported having onboard surveillance of passenger areas, 11 indicated it was also employed in operator/cab areas. There are considerable differences among modes in the availability of onboard surveillance. Only two agencies with heavy rail vehicles indicated that more than 76% of their railcars had video surveillance; an additional agency reported that new cars would include cameras. Six agencies with commuter railcars indicated that more than 76% of their railcars were equipped with video surveillance, while 16 light rail systems indicated that more than 76% of their LRVs had surveillance cameras (Table 4).

TABLE 4  
AGENCIES REPORTING MORE THAN 76% OF RAILCARS ARE MONITORED BY VIDEO SURVEILLANCE

Type	No.
Heavy Rail	2
Commuter Rail	6
Light Rail	16

It is difficult to account for the vast difference among modes without further study, but some conjecture is possible. Heavy and commuter rail, with a few exceptions, are generally older systems located in larger cities. Older systems are more likely to have railcars that were purchased before onboard surveillance was readily available pre-installed by vehicle manufacturers. The costs of retrofitting these vehicles could be too high and may not be cost-effective depending on whether there are plans to purchase new vehicles. It is more likely that newer agencies, which most often are light rail systems, obtained LRVs with preinstalled surveillance capabilities.

In general, onboard surveillance appears to have become far more common since a 2001 TRCP synthesis. Yet direct comparisons are difficult because of the dissimilarity in the population surveyed. In that study, *Electronic Surveillance Technology on Transit Vehicles*, Maier and Malone (2001) queried 32 agencies. Although 14 of the 30 largest U.S. transit agencies participated, only 16 were rail agencies (6 operated heavy rail and 11 provided light rail service). In addition to those that reported having onboard surveillance, some agencies were planning to install it; others were in test mode and the systems were not yet operational. Of the agencies that responded that they had surveillance onboard vehicles, 11 of 23 indicated that less than 25% of their railcars were equipped with this technology and only 3 reported that between 76% and 100% of vehicles had cameras. At that time, both BART and the Chicago Transit Authority (CTA) indicated that all new vehicles would be equipped with surveillance systems but they did not specify whether these would include cameras in operator areas/cabs.

In replying to the current synthesis questionnaire, BART was less definitive as to whether all vehicles would be so equipped while CTA continued to indicate that it anticipated installing surveillance in passenger and operator/cab areas of all new vehicles. The length of time between the two studies may account for the change in BART's response but also indicates that multi-year implementation plans may change as budgets change or as new priorities develop.

Overall, the number of agencies committed to equipping all new railcars with surveillance technology had increased substantially since the earlier study (Table 5). Although vehicle manufacturers are now able to routinely accommodate orders for onboard surveillance, fewer agencies reported that their plans called for surveillance on new vehicles than those reporting the same for station design plans.

TABLE 5  
WILL ALL NEW VEHICLES INCLUDE SURVEILLANCE VIDEO ONBOARD?

Surveillance Onboard?	No.
Yes, Plans Call for Surveillance:	29
In passenger areas only	13
Passenger areas and operator/cab areas	14
No, Plans Do Not Call for Surveillance	10

Onboard surveillance systems have a longer history on buses than on railcars; many of the systems that pioneered their use on railcars were multimodal agencies that expanded surveillance to railcars after successful applications on buses. For instance, the Bi-State Development Agency in St. Louis, Missouri, had installed surveillance systems on both buses and its LRVs primarily to curb disruptive behavior by juveniles. Because Bi-State's MetroLink security staff

did not regularly ride the light rail system, the agency provided images obtained from the video cameras of problem activities to school officials so that individuals responsible for causing problems could be identified and disciplined through the school system. NFTA in Buffalo, New York, also relied on surveillance to curtail unruly student behavior on its buses but not on its railcars. NFTA indicated for this synthesis that surveillance was employed in onboard passenger areas and that new vehicles would be similarly equipped, although there were no plans for operator/cab surveillance.

Maier and Malone (2001, pp. 14–17) found that in Philadelphia, SEPTA also recorded the interior of buses for after-incident reviews of its video images but did not do so in its railcars. SEPTA's dual interests were in curtailing the behavior of unruly teens and also reducing fraudulent claims. To achieve these goals, the introduction of surveillance was widely publicized through the local media, resulting in what SEPTA considered a significant reduction in claims of approximately \$15 million per year compared with 1991 data. Another multimodal system with cameras on buses but not railcars was CTA, which hoped to curtail bus crime, graffiti, and scratchiti, and planned to use the video for post-incident review. Neither system was considering similar experiments for its railcars.

Tri-Met, another bus/rail agency, decided to install video on its railcars based on the success of its pilot program on its buses. Tri-Met had piloted the use of cameras on three buses in 1987; by the early 1990s about 40 buses had been equipped and at the time of Maier and Malone's study the agency had budgeted \$1.2 million for a surveillance systems on 72 of its LRVs, hoping to rely on the video not only for deterrence and for post-incident investigation, but also to provide evidence in civil (tort) cases involving passenger injury claims. By 2010, Tri-Met noted on its website that all MAX/WES trains, most train stations, and all parking garages and elevators were equipped with surveillance.

As indicated in Table 5, only a small number of agencies employed video surveillance in operator/cab areas. An even smaller number anticipated that all new railcars would have this preinstalled. Whether this will change cannot be anticipated, but the federal government has shown interest in this issue following the crash of a Southern California Regional Rail Authority (Metrolink) commuter train in Chatsworth, California, in 2008. Twenty-eight people were killed in that incident, including the engineer, who, later investigation determined, was composing a text message when he ran a red signal and collided with a freight train.

In early 2010, the NTSB recommended that cameras be required in all locomotives as a management tool to ensure that operators are not sending text messages, talking on cell phones, sleeping, admitting unauthorized persons into the

cab area, or violating other FRA safety regulations. Metrolink installed two cameras that observe cab activities; the cameras remain despite a lawsuit filed by the Brotherhood of Locomotive Engineers and Trainmen to have them removed. If upheld, this safety regulation would exceed those in aircraft, where cockpits are not under constant surveillance for safety rule violations but are equipped with voice recorders used to investigate accidents. Because Metrolink, a commuter rail agency, is regulated by the FRA rather than the FTA, it is unclear whether the regulations could ultimately apply to FTA-regulated agencies.

Pending resolution of the litigation, in May 2010, Metrolink barred one engineer from operating trains and another was under investigation for having allegedly tampered with the surveillance cameras. The allegations involve attempts at blocking the cameras' view. Indicating how easily expensive, sophisticated equipment can be outwitted, the charges in one case involved clipping a paper to a visor to block the camera and in the other case involved turning the camera and putting a visor in front of it to block its view. The union contended that the actions were taken because sun visors that were moved to accommodate the cameras make it more difficult for engineers to see clearly when there is a glare. Metrolink has countered this claim by noting that it has issued engineers sunglasses and that visors are still available ("Metrolink Says..." 2010). The United Transportation Union (UTU) gave the matter prominent coverage on its website, noting, somewhat ironically, that the actions that led to action against the engineers had been captured by the cameras that are the focus of the dispute. The union does not accept the agency's viewpoint that there is "no expectation of privacy in a locomotive cab" ("Metrolink Engineers Probed..." 2010). How the courts resolve this dispute will have an impact on the use of video images in internal disciplinary matters and will be likely to influence a number of administrative issues discussed in chapter four.

## **PARKING FACILITIES**

Surveillance is common at parking facilities; 28 agencies indicated they employed cameras in these locations. Installation of video surveillance in parking facilities, whether open lots or multistory structures, provides assurance to patrons that they and their vehicles are safe while in the facility. Rail lines that rely on riders who park in the morning and leave their vehicles until they return at the end of the work day must be particularly careful to assure patrons that their vehicles are safe from theft and vandalism. Because vehicles parked in one spot all day are typically targets for theft or vandalism, parking facility security also has wide-ranging implications for risk management as patrons are likely to report these violations to the transit or local police and to their insurance carriers to claim reimbursement for loss or damages.

Parking lot crime can also result in damage to an agency's image. Such crimes are likely to gain considerable media attention, particularly on commuter blogs. BART became an example of this when the *EastBay Express* article "Lots of Trouble" reported on a series of parking lot crimes in summer 2007. In one case, three teenagers attacked a man and fled with his cell phone and laptop; in another, six men attacked another man, hurling him to the ground and demanding money (Atlas 2008).

### Protecting the "Whole Journey"

Although in these cases both the victims were men, the fears surrounding what has come to be termed "the whole journey" have been associated with the fears expressed by women. The whole journey concept goes beyond the stations, platforms, shelters, and railcars themselves to include public bus shelters, parking lots, and even the walk or ride to or from home to the transit station. In their study, *How to Ease Women's Fears of Transportation Environments*, Loukaitou-Sideris, and colleagues (2009, p. 50) found that security measures in the more enclosed and easily controllable parts of the transportation system (defined as the buses, trains, and station platforms) and the relative neglect of the more open and public parts (bus stops and parking lots) did not serve women's needs. This is because women were more typically fearful at desolate bus stops or walking through parking lots devoid of human activity than they were once on their buses or trains.

Although conceding that transit agencies lacked the resources to assign police officers throughout the system, the researchers pointed out that the installation of cameras, while less popular with patrons than uniformed officers, was less expensive and was a more likely response to such fear. According to Norman D. Bates, president of a risk management consulting firm, women's fears are not unfounded. He has estimated that as many as 40% of rapes and assaults take place in parking lots (Atlas 2008). In addition to the risk this presents it has profound implications for transit ridership; those who are overly fearful of having to retrieve their vehicles from parking facilities are unlikely to consider using mass transit.

### Camera Placements

Outdoor parking facilities in areas without extreme climate changes may be fairly easy to protect, but indoor multistory lots require more planning than merely placing cameras anywhere on any floor. Denver's RTD, for instance, places its cameras so that the areas under observation include elevator waiting areas and emergency telephone locations, among others (Figures 2 and 3).



FIGURE 2 Cameras are often placed adjacent to stations near malls, tourist attractions, or college campuses. This camera placement at the light rail station near Denver's Metropolitan College campus is designed to blend into campus design elements. Photo courtesy of Dorothy M. Schulz.



FIGURE 3 Denver's RTD places cameras near handicapped access ramps. Photo courtesy of Dorothy M. Schulz.

Houston METRO is one of a large number of agencies that monitor park-and-ride facilities to prevent a variety of crimes, including vehicle thefts and thefts from vehicles. Cameras also can be used to observe that patrons are not annoyed by panhandlers or do not become the victims of more serious crimes. Staff members who are monitoring the cameras are often able to communicate with drivers in the parking facilities and to control a number of lots' electronic gates through their central operations center (Nakanishi 2009, p. 23)

Lighting and the color of ceilings and walls can also influence camera placement. Another decision point is whether the cameras are primarily for patron and vehicle safety or whether they are placed to observe payment booths to minimize the possibility of people parking without paying. Focusing a camera on the entry/exit booth may also allow the transit agency to observe whether booth attendants are properly charging patrons and recording the fees. Camera placement may also be influenced by whether the booth attendants need to be protected so that they do not become crime victims.

Parking facilities were among the first facilities where transit systems relied on video cameras to assure patrons of their own safety and the safety of their vehicles. Reflecting the recognition that patron fears relating to parking facilities had a major impact on ridership, three of the field tests undertaken by Interactive Elements Inc. for a TCRB study of transit police/security deployments, *Guidelines for the Effective Use of Uniformed Transit Police and Security Personnel*, pertained to parking lots. In those tests, MARTA implemented bicycle patrol by its police officers to enhance visibility at a large heavy rail station and bus transfer point that had been the scene of thefts of and from autos. Employing a different strategy, Metrolink worked with the Claremont, California, Police Department to assign a local, nonsworn uniformed officer in a marked patrol car to a post in the parking lot. In both tests, crime dropped.

The LIRR field test for the same study was an early example of the use of surveillance technology in conjunction with covert policing tactics. Based on patron surveys in the early 1990s, the LIRR had learned that customers were concerned about parking lot security and auto-related thefts. This led to a number of its police officers being assigned to these outdoor lots, which resulted in an increase in arrests for either theft of the autos themselves or thefts from the vehicles. By 1993, in response to legislative hearings that stemmed from the December 7, 1993, shooting on an LIRR train that resulted in six deaths, parking lot security became an issue. The importance of parking lot security to patrons was evident; even though the shooting occurred on the train and parking or parking lots were not involved, Given the opportunity to comment on their safety and security concerns LIRR patrons chose to focus on something far more mundane than the shooting.

From the hearings, then-LIRR Police Chief John J. O'Connor found that the stereotypical "Dashing Dan" was now also "Dashing Dianna"—40% of the primarily business commuter ridership on the LIRR was female, and, in an echo of what the TTC/METRAC study had found, women had higher fear levels than men. The auto crime officers, who worked in street-clothes in conjunction with local police, were arrest-oriented and were able to bring the theft statistics down more than 50% between 1993 and 1995 (Interactive Elements Inc. 1997). Members of the unit attributed their success to the availability of unmarked cars that allowed them to remain surreptitiously in the parking lots but also to having a member of the team monitor surveillance cameras within the lot so that the plainclothes officers in the lot could be quickly dispatched to arrest the thieves in the act of stealing parked vehicles (Schulz and Gilbert 1995, p. 27).

Adding surveillance to parking facilities addresses patron fears and may result in lowered crime rates, but it also has important implications for risk management. Because of the extensive literature on parking lot crime and the importance

of design and oversight of parking facilities, those who are victimized in these areas are likely to file claims or lawsuits against the agency responsible for the facility. Based on the doctrine of "foreseeability"—that it could be anticipated that something would occur in a particular location if left unattended or unprotected—such lawsuits generally allege negligence based on such factors as an insufficient number of police/security officers, a lack of patrols, or an absence of such common security measures as emergency telephones, adequate lighting and signage, and electronic video surveillance. Surveillance policies may be further questioned as to whether the cameras are monitored in real time, which may present issues if patrons believe that help is on the way when that is not so (Jones 2006).

#### **STORAGE YARDS, OTHER YARDS, AND ADMINISTRATIVE AREAS**

Surveillance technology was heavily employed in areas in which equipment is stored or in administrative areas. In both situations, more than half the respondents (26 for storage and other yards and 28 in employee and administrative areas) indicated they relied on surveillance systems to safeguard these areas and, in some cases, to monitor employee activities.

Onboard surveillance in operator/cab areas remains controversial, but use of video cameras in other employee administrative areas has become commonplace. A number of reasons can be posited for this. Cameras in employee areas require no technological features different from those required in other industries. But cameras in yards and other outdoor facilities may require greater planning and the need to include special features to protect the cameras themselves from damage or vandalism. Placement of cameras in yards and other employee-related areas can also be seen as providing not only oversight of employee actions but also protection for employees. Employees, particularly those working in remote locations, can be victims of crime. Just as cameras may be seen as enhancing risk mitigation and management oversight, they may also be seen as crime prevention mechanisms for protecting employees and their property.

A number of transit agencies have used video surveillance in employee areas for decades, including Buffalo's NFTA and Cleveland's RTA, which in addition to monitoring key revenue facilities as early as the mid-1990s maintained a surveillance vehicle for covert operations (Gilbert 1995). Although a wide variety of locations were listed among the types of employee facilities where video was installed, a number of generalizations are possible. Surveillance tended to be employed most frequently in equipment yards and wherever personnel had access to large amounts of cash. The other most-frequently-listed location was the operations control center. Fewer than half the agencies indicated that

their headquarters buildings were monitored by video surveillance but a small number indicated that all agency locations, including satellite offices, were monitored. Customer service areas and public lobbies; TVMs; and warehouses, storerooms, loading docks, and commissaries were among the locations listed as under video monitoring. One agency noted that its incline plane control station and the souvenir gift shop were monitored.

**RIGHT-OF-WAY SURVEILLANCE**

Use of video surveillance technology along the ROW was uncommon. Of the 43 responding agencies, only 14 indicated that they used surveillance along the ROW. Of these, 12 indicated its use primarily near stations. Only two agencies reported the use of surveillance at grade crossings and two indicated its use at interchanges with other railroads (Table 6).

TABLE 6  
LOCATION OF RIGHT-OF-WAY VIDEO SURVEILLANCE

Installation Location	No.
Near Stations, Station Platforms, or Shelters	12
At Grade Crossings	2
At Interchanges with Other Rail Systems	2
In High Disorder/Crime Areas	3
Other	7

The number of uses exceeded the number of agencies because some agencies that employed ROW surveillance used it in multiple locations. Illustrative of the importance of local decision-making, it is difficult to generalize about the agencies that employed ROW surveillance or about the sub-categories listing where they used it. For instance, the two systems that reported using surveillance at grade crossings included an old, established West Coast multimodal system and a light rail system that recently added a small number of trolleys to augment its primarily bus transit system. Similarly, the two systems that indicated use of surveillance at interchange locations were the same trolley system that had installed cameras at grade crossings and a long-established Midwestern commuter rail line. Three agencies indicated the presence of surveillance equipment in areas they defined as high disorder or crime areas.

Seven agencies, including one case study agency (Minnesota’s Metro Transit), had installed surveillance in areas listed as “other”; in most of these instances, “other” was defined as critical areas such as subways, bridges, and tunnels. Of these agencies, all but Metro Transit were commuter or heavy rail systems, although one smaller system included

surveillance at the entrance to its yard in this category and another included pedestrian crossings near a bridge. This small system, in operation since 2004, also reported that it relied on surveillance only along its ROW and that no other portions of the transit system were monitored by video cameras. Phoenix’s Valley Metro (another case study agency) did not state in its questionnaire response that it employs any ROW surveillance, but protection of its Town Lake Bridge in Tempe, Arizona, is a major element of its surveillance network (see chapter five).

Although passenger rail systems do not generally conduct surveillance of the ROW, a number of bus systems have employed it to assist in injury claims adjudication or, less frequently, to monitor for suspicious activities. In these instances, cameras were installed not only inside buses to cut down on crime and vandalism, but also outside the vehicles to monitor activity along the bus route and to alert operators to suspicious activities. For instance, HARTline, in Tampa, Florida, began using surveillance along its bus transitway in the 1990s to alert supervisors to suspicious activities. Broward County, Florida, did the same, hoping to cut down on crime and vandalism but also on accident and injury claims that drivers could not verify owing to their inability to monitor all areas of the bus from the front seat (Gilbert 1995).

Intercity Transit in Olympia, Washington, which maintains 22 separate bus routes, installed cameras on its approximately 100 buses and vans to better managing public safety and to mitigate liability. A 35% increase in riders over a 5-year period, combined with a number of assaults in downtown Olympia, led to the decision to integrate the cameras into the existing global positioning system (GPS) and alarm systems to “increase security initiatives, deter vandalism and theft, mitigate accident and liability claims, and enhance operations.” According to transit management, although none of the assaults were on bus operators, stabbings near the transit system led to customer fears of crime, a concern that it was believed would be addressed by the added surveillance (“More Traffic...” 2007). This is an example of a transit agency’s awareness of the whole journey concept. By responding to events that occurred off its premises but in its immediate area of operation, Intercity recognized that patron fear could discourage ridership.

**Deterring Trespassers with Video Cameras and Sensors**

The increase in the number of cities using cameras to photograph and send summonses to red-light and right-turn-on-red violators has the potential to expand into a way to provide ROW surveillance or, more likely, to photograph and fine railroad crossing gate violators. Although none of the transit agencies specifically mentioned using surveillance this way, a number have turned to photo enforcement cameras to minimize deaths and injuries and to mitigate liability at rail crossings.

LACMTA installed photo-enforcement cameras along the Blue Line in 2007; violators were fined a minimum of \$271 for the first offense (Abdollah 2007). In early 2009, the city of El Mirage, Arizona, expanded its traffic cameras to a Burlington Northern Santa Fe (BNSF) railroad crossing, contracting for a system called Redflexrail, which detects when vehicles drive around railroad crossing gates and also records the bell sounds and whistles of approaching trains. As with most red-light camera operations, the costs of installation, operation, and maintenance is borne by the contractor and the city pays the company a portion of the fines that are collected. Although the idea was not BNSF's, the freight railroad has been in talks with other contractors about implementing camera-based crossing enforcement. A BNSF spokesman noted that the railway supported video enforcement because it could "influence driver behavior at rail crossings and increase driver safety" (Leung 2009).

A similar plan was instituted in Sydney, Australia, in 2006, when mobile cameras, fences, and warnings signs were erected along a number of rail corridors in a campaign intended to deter people from walking over the tracks. The initiative was instituted after CityRail reported more than 2,300 instances of trespassing in 2005–2006, resulting in 23 deaths and 11 serious injuries. The remote-controlled cameras, called Spycams, which cost about \$250,000 each, can be used in poor light and at night and are portable enough to be moved to trespassing "hot spots" by railway employees (Silmalis 2006). A number of U.S. rail agencies use similar mobile cameras mounted on lifts with adjustable heights to provide temporary coverage in outdoor parking lots where a series of crimes have been reported. The cameras are then moved to new areas as problems and activity shifts from facility to facility.

A number of the case study agencies (see chapter five) are using or are planning to use photo enforcement in combination with sensors to deter both vehicles and pedestrians trespassing on their alignments. Metro Transit uses cameras equipped with analytics to monitor portals into tunnels and at Minneapolis' Lindbergh Airport to supplement its intrusion detection system. Houston's METRO is in the process of expanding its surveillance network to add cameras along its alignment that would monitor nontransit vehicles that make illegal turns into its alignment. PAAC has relied on chemical/radiation-detection sensors in a number of its downtown subway stations since 2006–2007. And Valley Metro relies on a combination of intrusion detection and surveillance cameras to protect the Tempe Town Lake Bridge.

Many transit systems are reluctant to discuss their use of sensors, particularly because many of the installations are seen as terrorist-related early warning systems for detection of chemical, biological, radiological, nuclear, and explosive materials. Despite this, some information can be gleaned from media accounts, vendor announcements, and

other public documents. Relying on these sources, among the transit systems that have installed motion detectors and sensors are MTA (New York and Connecticut), MTA-MD, LACMTA, Amtrak, WMATA, NJT, SEPTA, and MBTA. Most but not all of these agencies purchased all or part of their sensor systems with the help of DHS grants. However, not all published sources are reliable; as recently as 2009, at least one video surveillance blog stated that BART had announced in 2007 that it would be expanding its existing surveillance system to include cameras along the tracks, but responses by BART to this synthesis' questionnaire did not confirm this information.

### Right-of-Way Trespassing

Deterring trespassers from the ROW is an area in which crime prevention and risk mitigation strategies and concerns overlap. Trespassers may be innocent of any ill intentions toward the transit system, but they may cause damage to property or injury to themselves. They may also be malevolent. Reviewing the British response to IRA terrorism as part of a larger study, *Protecting Public Surface Transportation Against Terrorism and Serious Crime: Continuing Research on Best Security Practices*, undertaken for MTI, Brian Jenkins and Larry N. Gersten found that as stations were better protected, usually through use of video technology, attackers moved their attacks to switch boxes and areas away from stations (p. 20).

Because these crimes often occur in remote locations, they are difficult to solve, as with the derailling of Amtrak's Sunset Limited in Hyder, Arizona, on October 9, 1995, about 59 miles southwest of Phoenix, Arizona, on an isolated portion of Southern Pacific Railway's ROW. The train carried 248 passengers and a crew of 20; the derailment caused 65 injuries and the death of one employee. Property damage was estimated at close to \$3,000,000. The crime had been committed by the removal of spikes from the rails, the removal of nuts and bolts from the rail joints, and the disabling of the signal system, in addition to other acts of vandalism. Despite evidence found at the scene indicating an intentional derailment, the crime has never been solved (*Terrorism in Surface Transportation* 1996).

Such incidents are not unique to the United States. In the 2007 RAND Corporation study *Securing America's Passenger-Rail Systems*, Jeremy M. Wilson and colleagues broke down terrorist attacks on rail systems worldwide from 1998 through 2006. Their database contained 24,000 attacks, of which 455 were against solely rail targets (2% of the total). They also noted that recent attacks were more numerous and were a source for concern owing to the number of casualties and significant damage to the rail system that they caused. Further refining their database to 886 incidents, they found that of incidents where a weapon was involved, the percentage that occurred inside railcars, in stations, and on the

tracks was virtually identical (26, 25, and 25, respectively). Of the incidents that occurred on the tracks, they considered 79% to have been caused by bombings, 16% through sabotage (defined as damage without use of a weapon, such as removal of rails or damaging equipment), 2% by armed attack, and 2% by arson. Although it is impossible to confirm this claim, video surveillance along the ROW might have prevented or in some way mitigated the effects of some of these track-related incidents.

Current DHS projects that involve passenger rail agencies are intended to provide ROW protection by extending the reach of electronic video surveillance from patron and employee areas to the tracks. In addition to those mentioned as already having received DHS funding, system upgrades currently under way generally call for a network based on surveillance and remote sensing equipment. One current plan involves monitoring tunnels and tracks leading into and out of Washington, D.C., as part of the National Capital Region Rail Pilot Program and the Amtrak Security Pilot Program. The Rail Pilot Program, authorized in 2006 by the National Capital Planning Commission, provided \$10 million for a pilot project to create a virtual boundary through an 8-mile section of ROW through the DC Rail Corridor, which includes Union Station, L'Enfant Plaza, the Virginia Avenue and First Avenue tunnels, and the Long and Anacostia bridges.

According to the DHS notice posted in the *Federal Register* in November 2007: "The virtual boundary (fence) shall consist of video camera technology integrated with intelligent vision interpretation software that will enable the system to detect moving objects, detect intruders crossing virtual boundaries, identify personnel loitering in the area, and identify unauthorized suspicious objects left behind or objects removed along the rail line" ("Sophisticated Surveillance..." 2007, p. 44).

The system is based on real-time monitoring not only of video images, but of data and alarm information at three police communications centers; CSX Corp. will maintain one at its Jacksonville, Florida, headquarters and Amtrak will maintain two, both accessible in Philadelphia and New York City. Also part of the program is an explosive detection

system and installation of chemical detection sensors along 5 miles of track. The combination of agencies involved in the project includes police staff from Amtrak and CSX. Data will be available to the Washington DC Metropolitan Police, the U.S. Capital Police, the National Park Service Police, and other agencies to be authorized by DHS.

In an earlier system upgrade that was also supported by funds from DHS, the Delaware River Port Authority used its \$3.8 million grant to upgrade surveillance at 14 rail stations and tunnels between rail stations adjacent to its 14-mile-long ROW. As part of the overall project, which included installation of more than 250 cameras and almost 100 emergency telephones, cameras were to be installed above and below the Ben Franklin Bridge, a seven-lane highway with tracks on either side that connects Philadelphia to southern New Jersey. The under-the-bridge cameras were intended to monitor passing boats and mitigate the risk of a water-borne terrorist attack (Stelter Sept. 2008).

In a separate project, in 2006 the UPRR began to introduce wireless surveillance video and sensors to its 7,000 locomotives with the aim of permitting centralized monitoring and recording of a train's path, maintaining a record of brake use, and recording the use of horns and bells. The system is different from Metrolink's use of surveillance inside locomotives. The UPRR plan is not meant to track the activities of engineers, but to permit locomotive operators to access video during security-related events (Marcoux 2006, p. 14).

A number of areas involving ROW surveillance have so far received limited attention, including the use of surveillance onboard vehicles to monitor the ROW from inside the vehicles or from remote locations. As with the use of cameras and sensors for traffic or trespasser control, these areas await further study. As technology improves and information about these pilot projects receives wider publicity at rail industry gatherings and in industry publications, it can be anticipated that there will be a greater focus in these areas, particularly if antiterrorism funds continue to be available from DHS or if transit agencies develop methods for partnering with local authorities, particularly in controlling unauthorized access to light rail alignments by road vehicles.

## ADMINISTRATIVE CONSIDERATIONS IN THE USE OF ELECTRONIC VIDEO SURVEILLANCE

### INTRODUCTION

As surveillance technology advances and its use becomes commonplace throughout the transit industry, agencies are being presented with an expanding list of places that it can be employed. The decisions are not made in a vacuum, and once a decision to rely on video surveillance is made, a number of questions arise. An important question is whether the cameras will be monitored in real time or used solely for forensic investigation. Once this is decided, additional questions must be answered. For instance, if the system will be viewed in real time, will it be always monitored or only during operating hours, and who will do the monitoring (i.e., police/security, rail operations, or some combination of these staffs). Whether viewed in real time or later, questions need to be answered about how and where images will be stored and who will have access to them. Additional questions may arise surrounding whether those on the transit system's property (patrons, employees, or even trespassers) should be informed that their actions are being monitored by video surveillance.

This chapter relies on questionnaire responses and the literature review to provide a snapshot of how agencies have answered some of these questions. It also provides examples of how such decisions impact policies and procedures.

### DECIDING WHERE TO INSTALL VIDEO SURVEILLANCE

The use of surveillance in the United States is not as widespread as it is in the United Kingdom, but it has been steadily expanding. It is not unusual for newspaper readers around the nation to see stories about their cities increasing their reliance on cameras for a number of crime prevention efforts. New York City, Chicago, Baltimore, and Pittsburgh are only a few of those whose mayors have spoken frequently on the issue, and many smaller cities have turned to cameras without the fanfare and publicity of these larger municipalities (Figure 4). Announcements of transit agencies' expansion of their surveillance networks also receive local attention from the media.



FIGURE 4 The New York City Police Department posts signs on local streets indicating the presence of security cameras. This sign was across the street from a Manhattan subway station. *Photo courtesy of Dorothy M. Schulz.*

To provide some guidance on why certain surveillance installations and placements were made, agencies that had installed surveillance cameras on fewer than 76% of their stations, station platforms, or shelters were asked why certain locations were covered and others were not. Using a five-point scale ranging from least to most important, the two most important factors in determining which stations, station platforms, or shelters had surveillance or on which it might be installed were “high disorder/crime rate” and “funds available to retrofit” (Table 7).

Decisions on where and when to employ electronic surveillance may be influenced by patron expectations, which have changed considerably with the current focus on safety and security. For instance, when, on December 7, 1993, Colin Ferguson shot 23 people—6 fatally—on an LIRR train, no one asked why the railcar lacked surveillance video. The response to this event may have been tempered by Ferguson's immediate capture by an off-duty transit officer, but more recent crimes on transit properties that are not captured

on video leave the agency subject to criticism. For instance, in May 2010, NYCT was criticized after an encounter in a Greenwich Village subway station that was not captured on video led officials to admit that almost half the cameras in the subway did not work. Ironically, the absence of video played no role in the case. The 19-year-old suspect arrested in the deaths of two other men was released when a grand jury refused to indict after deciding he had acted in self defense (Eligon 2010, p. A13).

TABLE 7  
MOST/LEAST IMPORTANT REASONS FOR INSTALLING VIDEO SURVEILLANCE ON STATIONS, STATION PLATFORMS, AND SHELTERS

Reason	Most Important	Least Important
High disorder/crime rate	4	1
Local demands/politics	3	3
Enhance perceived customer safety	2	1
Funds available to retrofit existing stations, station platforms, or shelters	4	1
New stations, platforms, or shelters designed to accommodate surveillance devices	2	0
Other (none specified)	0	0

Similarly, agencies that reported that fewer than 76% of their railcars were equipped with surveillance technology were asked to indicate the most and least important reasons for equipping some vehicles and not others. Table 8 indicates the number of agencies for whom choices were most and least important.

TABLE 8  
MOST/LEAST IMPORTANT REASONS FOR EQUIPPING RAILCARS WITH VIDEO SURVEILLANCE TECHNOLOGY

Reason	Most Important	Least Important
High disorder/crime rate	1	2
Local demands/politics	2	4
Enhance perceived customer safety	4	0
Funds available to retrofit existing railcars	2	2
New railcars equipped at purchase	2	3
Other (none specified)	0	0

Although only a small number of transit systems indicated that politics played a role in installation of surveillance cameras, a number of major cities' mayors have been vocal in their support of video surveillance throughout their cit-

ies, including the local or regional transit systems. Two of the most vocal officials have been Chicago's Mayor Richard M. Daley and New York City's Mayor Michael Bloomberg, whose cities contain, respectively, the second-largest and largest U.S. transit systems. Differences in the current status of surveillance-related issues by CTA and NYCT highlight not only political issues, but also problems that may occur with vendors, particularly in retrofitting aging heavy rail transit systems.

In May 2010, Mayor Daley and CTA President Richard L. Rodriguez announced that by May 31 at least one or more surveillance cameras would be installed in all 144 CTA stations and that nearly 3,000 cameras would be installed by the end of the year ("Mayor Daley ..." 2010). The announcement came less than a year after Daley appointed Rodriguez CTA president and encouraged him to focus on improving the safety on the system. Crime on CTA had increased slightly in 2008 and early 2009, and when he was appointed Rodriguez noted that cameras were installed on every bus and that he hoped to have them at all train stations with 18 months.

The CTA has received \$22.6 million in DHS funds since 2006, a portion of which is being used to expand its network of cameras. Although the transit system has also invested approximately \$19 million of its own funds in the project, the importance of DHS funding was highlighted by Chicago Transit Board Chairman Terry Peterson, who noted that the DHS grants have allowed CTA to make "significant upgrades to the security and surveillance network" ("Mayor Daley..." 2010). CTA began adding cameras in 2002; in January 2011 Amy Kovalan, CTA's chief safety and security officer, announced that CTA would install cameras on about half its rail cars based on an existing DHS grant and had a "verbal agreement" from DHS to pay for installation on the remaining cars. An installation schedule was not provided ("CTA to add security cameras to trains" 2011).

The Chicago Police Department, whose transit division provides policing for the CTA, estimated that cameras had played a role in more than 4,500 arrests since 2006. Rodriguez also noted the importance of the cameras to the CTA Control Center, which views real-time video to assist in passenger safety by monitoring and managing service disruptions and by providing the City's Office of Emergency Management and Communications the ability to communicate with police, fire, emergency response, and CTA personnel during incidents. In the past, although he has not provided specific numbers, Mayor Daley has stated that Chicago's network of public and private surveillance cameras is "the largest in the United States" (Spielman 2010). The announcement of the expansion of the surveillance network included information that all new railcars would arrive with cameras pre-installed and that a pilot program would be undertaken to determine the feasibility of retrofitting existing vehicles.

New York's mayor—and its transit system—have been less successful in plans to increase video surveillance in NYCT's subway system. Although its size and the age of the system combine to make NYCT unrepresentative of transit agencies, its experiences are instructive of problems that can occur, albeit on a smaller scale, for all transit systems. In April 2009, the MTA, which oversees the NYCT, was sued by its video surveillance contractor, Lockheed Martin. The company alleged that the agency's interference relating to its \$300 million contract to install a network of digital cameras had prevented it from completing work begun in late 2005. Two months later the MTA countersued, claiming Lockheed Martin had "bungled" the antiterrorism program that was intended to link 2,000 subway cameras into an intelligent video surveillance command center. At the time, the MTA stated that only about 1,400 of the 1,750 cameras were installed and that few were working. The basis of its countersuit was that the system had failed repeatedly during tests and that Lockheed Martin had falsely claimed the work was progressing even though about \$250 million had been spent (Namako 2009).

Regardless of the claims and counterclaims, some of the cameras' inability to capture video was attributed to the transit environment, where heat, water, and electrical problems slowed the job's progress. These are all factors that may limit attempts to retrofit a century-old transit system to accept modern technology (Rivera and Grynbaum 2010). The lawsuit is pending; because of this, MTA and its constituent agencies declined to reply to this synthesis's questionnaire.

Many factors may influence the decision to install a surveillance network in all or part of the transit system. In the case of Tri-Met, the route played a role because concern centered on its 5.5-mile Airport MAX line, which travels from downtown Portland to Portland International Airport. Since it began revenue service in September 2001, video surveillance has been employed along the line, but because the Airport MAX terminus was in close proximity to the air terminal, the FAA requested that no train be unattended at the airport. In addition to adding security patrols to the airport station during all operating hours and checking all trains for unattended items, Tri-Met installed surveillance cameras at the airport station. This also illustrates the expanded role of the federal government in local decisions since 9/11. Using grant funds, Tri-Met also installed cameras on all 78 MAX trains, at stations with elevators, and at a number of parking garages (Eder 2005, p. 1927).

#### **FUNDING VIDEO SURVEILLANCE SYSTEMS**

Because transit agencies are local entities, each needs to purchase surveillance equipment independently of other transit agencies. In the aftermath of terrorist attacks on transit systems worldwide, U.S. transit systems began to

receive considerable financial support for equipment and for employee training and terrorist awareness programs from the federal government.

As indicated by the responding transit agencies, currently the major funding source for surveillance systems is the DHS Transit Security Grant Program, followed by funding from the FTA. APTA has also increased its presence in transit security, and both it and the FTA have published a number of studies of best practices that were the basis for many of the directives issued by the TSA in 2004 to public transit agencies (Jenkins and Butterworth 2007). DHS/TSA has awarded grants for planning, training, equipment, and other security enhancements, in addition to providing other services to transit agencies. Some grant programs have been used to undertake risk assessments and bolster emergency response capabilities. The largest percentage of the available funds, though, is used for employee training and for the purchase of surveillance equipment.

Prior to the creation of DHS in the wake of the 9/11 terrorist attacks, FTA was the most common source of funds for purchasing equipment; Maier and Malone (2001) reported that 14 of their responding agencies, which included both bus and rail systems, received funds from the FTA grant program, 9 relied on state grants, 6 on local funds, 6 on internal funding sources, and 1 on an unspecified source. They noted, though, that about one-third of the agencies used a combination of sources to fund their purchases (2001, pp. 23–24). The FTA helps transit agencies fund security projects by providing financial assistance and by requiring that agencies spend 1% of their urbanized area grant program funds on security improvements. These funds are available to jurisdictions with populations of 50,000 or more for use for capital investments, operating expenses, and transportation-related planning.

The existence of DHS funding has had a direct influence on rail transit expenditures for security. For this study, agencies were asked to indicate the percentage of their funding that came from a number of sources, including the FTA grant program, DHS, state grants, municipal grants, agency funding, funding or grants from surveillance equipment vendors, or any other sources. Agencies were not asked to provide dollar amounts; they were asked only to indicate the percentages of funds from each source.

Table 9 indicates the number of agencies that listed receiving more than 50% of their funds for surveillance expenditures from any one of the choices provided and those that indicated that 100% of their funds came from any one source. Agencies that did not receive at least 50% of their funds from a sole source but from a variety of the sources are not included. One light rail system that anticipates revenue service beginning in 2011 received an equal percentage of funding from FTA and DHS (50% received from each).

Valley Metro in Phoenix, a case study agency, was the only agency whose surveillance network was funded solely with agency money. As a new transit system, it was not eligible for DHS grants but will be able to compete for such funds now that it is fully operational.

TABLE 9  
SOURCE OF 50%/ALL VIDEO SURVEILLANCE FUNDING

Source of Funds for Video Surveillance System	50% or More	All Funds
FTA Grant Program	11	2
DHS	10	4
State Grants	1	1
Municipal Grants	0	0
Agency Funding	1	0
Vendor Funding/Grant	0	0
Other	0	0

Because agencies were promised anonymity, analysis of the table is general. The two agencies that received 100% of their funds from FTA are recently opened systems. The agencies that received 100% of their funds from DHS include Amtrak (which is federally funded overall), two commuter, and one light rail agency. The agencies that received 50% or more of their funding from either FTA or DHS do not fall into easy categorization with the possible exception that a far larger number of FTA-funded agencies are newer systems in areas of the country that are less likely to be seen as major terrorist targets, although there were exceptions to either of these descriptions. With few exceptions, the agencies that received at least 50% of their funds from DHS were established transit agencies in urbanized areas.

The three agencies that received more than 50% of their funding from sources other than FTA or DHS are equally difficult to categorize. The agency that received all its funding from state grants is a new commuter rail system and the one that received 50% of its funding from state grants is an established light rail system located in a different state. Finally, the agency that funded more than 50% of its surveillance-related costs from its own funds is a large, long-established eastern seaboard agency.

Results received in answer to this question underline that the sources of funding for surveillance are limited even if the dollar amounts are considerable. Only a few agencies reported receiving funds or grants from vendors, and these generally cover 10% or less of their costs. Although commuter rail agencies are regulated by FRA and would be eligible for FRA financial support for surveillance initiatives including under the FHWA's Highway-Rail Crossing Program, none indicated this as a source of funds.

The responses overwhelming reinforce the importance of external funding for purchasing and upgrading surveillance systems. Although transit systems must in effect compete against one another for the DHS funds, the amounts of money available are larger than from any other single source. For instance, in May 2010 the DHS announced that it would release almost \$790 million in Preparedness Grants for nine federal programs. The Transit Security Grant Program was to receive \$253.4 million, plus an additional \$150 million provided through the first and second American Recovery and Reinvestment Act funding provisions. Also included in the total of \$790 million was \$20 million to Amtrak; \$14.5 million to the Freight Rail Security Grant Program for critical freight infrastructure projects centered on transportation of hazardous materials; and \$11.5 for the Intercity Bus Security Grant Program, which is available to fixed-route intercity and charter bus companies for security planning, facility upgrades, and vehicle and driver protection. Other funds are allocated to other areas of transportation infrastructure, including ports and terminals (Kronfeld 2010). Despite these large amounts of available money, politicians and the DHS's own Office of the Inspector General have consistently urged DHS to expand its effectiveness in the area of mass transit and passenger rail. A recent report, though, focused primarily on nonmonetary aid (Chunovic 2010).

Reinforcing the close ties between terrorism prevention and detection and risk management, DHS disburses funds only to agencies that have relied on its mandated methodology to complete a risk assessment. This requirement has resulted in a number of agencies that previously had not completed risk assessments undertaking them to be eligible to apply for funds. Basic eligibility to compete for funds is based on the Urban Areas Security Initiative list and the National Transit Database; eligible applicants are listed as part of the annual guidance published to assist agencies in completing the requests. DHS has further divided agencies into two tiers. Tier I is composed of transit agencies in the eight highest-risk urban areas as determined by DHS; Tier II consists of all other eligible transit agencies. Agencies are effectively competing against one another. Applications are evaluated by panels composed of federal employees who score the projects based on a number of criteria, including the agency's risk group score, the project's effectiveness group score, the project's potential for risk mitigation (which includes cost-effectiveness, feasibility, timeliness, and sustainability), regional collaboration if required, and the agency's offering of a cost share. Projects are ranked and funded in order until the funds are exhausted. All information and forms are available on the DHS website, as is information on Tier I-eligible agencies, the allocations for each Tier I area, and designation of Tier II areas and eligible agencies.

Some agencies are in more competitive areas than others. MBTA and MARTA, for instance, are the only Tier I

agencies in their states. Although ACE, a case study agency, is part of the San Francisco Bay Area Tier I, it competes for funds in that group (\$19,873,038 in FY 2010) with much larger, higher profile agencies in the Bay Area's Regional Transit Security Working Group. All other case study agencies are designated as Tier II.

Funding issues explored by this synthesis centered on purchase. The synthesis did not pursue costs and issues pertaining to the operation or maintenance of surveillance cameras, including the related costs of hardware or software that are required to maintain the surveillance system in an operational state. These costs are considerable and insufficient maintenance of an existing surveillance system can contribute to negative publicity about an agency and may influence how claims of loss or injury are adjudicated either by internal claims officers or by courts. Technical studies of the actual operations of surveillance systems by rail agencies might assist them in determining whether their initial purchases are being supported internally by policies and procedures that maintain the equipment properly. These studies might also consider how internal decisions impact the effectiveness of the video surveillance system and the transit system overall.

### PERCEIVED EFFECTIVENESS OF VIDEO SURVEILLANCE

Decisions about where to install cameras are influenced by an agency's goals, available funding, and, sometimes, concerns of the political entity to which the agency is linked. Intertwined in each or all of these decisions is the perceived effectiveness of the surveillance network. Although effectiveness might be difficult to define in the context of these overlapping but possibly contradictory goals, agencies were asked to indicate how effective their surveillance systems were in achieving a number of goals. The two major reasons for employing video surveillance monitoring of locations were for crime/vandalism prevention and accident investigation. Respondents could select as many or as few of the choices that pertained to their agency (Table 10)

TABLE 10  
REASONS FOR EMPLOYING VIDEO SURVEILLANCE

Reason	No.
Crime/Vandalism Prevention	39
Fare Collection View/Dispute Mediation	20
Other Complaint Resolution	32
Accident Investigation	39
Employee Monitoring	18
Other	10

Again using a five-point scale, agencies were given a list of the most common purposes of a video surveillance system and asked to rate from most effective to least effective whether they believed this goal was met on their system. Table 11 indicates the number of times an agency listed a reason as most effective and the number of times it was rated as least effective.

TABLE 11  
MOST/LEAST EFFECTIVE USE OF VIDEO SURVEILLANCE

Reason	Most Effective	Least Effective
Crime Prevention/Vandalism	7	2
Fare Collection/Dispute Mediation	4	4
Other Complaint Resolution	7	0
Accident Investigation	11	0
Employee Monitoring	0	0
Other	1	1

The perceived effectiveness of a video surveillance system can depend on a number of administrative issues beyond purchase, installation, and maintenance of the equipment itself. Transit systems need to address many operational issues when considering upgrading an existing surveillance system or installing a new one. Survey respondents provided information on how a number of these are addressed, including policies on monitoring, recording, and archiving images, and whether patrons and/or employees are notified of the presence of video surveillance technology.

### MONITORING VIDEO CAMERAS—WHEN AND BY WHOM

As the number of cameras increases, questions have arisen as to whether they will be monitored in real time (someone watching the cameras as things are happening) or will be viewed after the fact (looking at images after an incident occurred). A related decision is who will monitor the cameras and for what hours whoever is assigned will view them.

The times that video cameras are monitored differed considerably. Twenty-two agencies indicated their cameras were monitored at all times (24 hours a day, 7 days a week), and six reported that cameras were never monitored. Eight responded that cameras were viewed only during hours of transit operations, while 11 indicated they used a configuration that was not easily summarized but met their agencies' needs (Table 12).

TABLE 12  
WHEN VIDEO CAMERAS ARE MONITORED

When Monitored	No.
24 Hours a Day, 7 Days a Week	22
During Hours of Service Only	7
Another Configuration	7
Not Viewed	9

*Note:* Two agencies checked multiple responses.

Although some agencies checked multiple responses, making it difficult to fully interpret the responses, the largest number of agencies indicated that their cameras are under constant monitoring and the smallest number indicated that the cameras are not viewed at all in real time. The six agencies that reported that cameras were never monitored in real time stated that the decision was based on the cost involved in having personnel assigned to this function, although two also indicated that other unspecified factors played a role in their decisions.

Once an agency decides that cameras will be monitored, it must decide who will monitor them (Table 13). Although the synthesis did not delve into many areas of personnel decision-making, such as whether labor agreements were a factor, the agencies that reported that cameras were not viewed listed cost as the major reason for this decision. In most agencies, rail operations personnel are assigned to monitor system operation during all hours train are running and sometimes even when they are not. Because cameras serve a number of non-law enforcement purposes, having rail operations personnel monitor video systems is consistent with the camera's overall roles in safe operations of the rail network. On other systems, where there is a full-service 24/7 police agency that monitors emergency telephones and responds to incidents on the transit system, having those individuals monitor the surveillance network is also consistent with their roles.

TABLE 13  
PERSONNEL MONITORING VIDEO CAMERAS

Who Monitors	No.
Police/Security Personnel	10
Rail Operations Personnel	8
Combined	22

*Note:* Not all agencies responded.

Without more information, for instance, whether union agreements played a role in the decision, whether the initial purpose of the video system played a role in the decision, or whether existing communications networks were used to activate the surveillance system, it is difficult to generalize as to how a combined network came to be the preferred method. Recalling that the earliest federal report noted that

transit policing was established by 1979, it may simply stem from the initial view of surveillance as primarily a patron traffic control and rail operations tool rather than a law enforcement tool. It may also simply reflect a continuation of past practices.

## VIDEO SURVEILLANCE SYSTEM FEATURES

Many of the questions pertaining to the technological features of an agency's surveillance system did not receive replies or received replies that were internally inconsistent. As with all questionnaires, it is difficult to determine why some questions are answered and others are not. Many respondents were vague about when surveillance was introduced on their system. This, in combination with the few responses to a request to provide the name of the surveillance vendor, supports a tentative conclusion that managers responsible for daily operation of the surveillance system are less interested in the technical specifications of their systems than in its day-to-day use and reliability. With this caveat, it can only be stated that most agencies rely on digital rather than analog systems, and that more than a third described their surveillance systems as combined or in transition from analog to digital.

Particularly given the current attention paid to video analytics, most of the existing surveillance systems were described by respondents as having what today would be considered relatively low-tech features (Table 14).

TABLE 14  
VIDEO SURVEILLANCE SYSTEM SPECIAL FEATURES

Special Feature	No.
24-hour Recording	36
Auto Emergency Digital Transmission	4
Secondary Power Source	18
Auto-start	8
Low Light Resolution	16

## VIDEO ANALYTICS

As video surveillance has proliferated two new issues have emerged: perception overload and the expanded use of sensors in conjunction with cameras or as stand-alone tools to protect vital areas. Both rely on advanced technology that a number of agencies are introducing into their video surveillance networks. Even in agencies that assign personnel to monitor images in real time, the rise in interest in video analytics is based on the realization that most surveillance systems produce far more images than it is possible for viewers to absorb. The use of video analytics ("smart" or "intel-

ligent” video) attempts to provide a solution. At its most simple, smart video can be defined as video that thinks for you. It not only collects data, but is capable of analyzing the data; for instance, in addition to merely filming individuals on a crowded platform, smart video would identify and focus on persons who act suspiciously and would alert those in the viewing room to turn their attention to the monitor displaying this particular action.

Scientists who are studying it and vendors who are marketing it refer to smart video as the next-generation of electronic video systems. Such systems rely on algorithms to profile behavior based on how people usually behave in certain environments and then picking out those whose behavior is different from others or inappropriate for the location or situation. These systems take into consideration changes in lighting conditions, an important factor for rail facilities and parking locations, and can track people as they move from one camera to the next.

### **Understanding and Using Analytics**

Video analytic systems analyze data to improve tracking. They are programmed based on what people can be anticipated to do. If normal behavior can be anticipated, abnormal behavior can be made to stand out. For instance, to track an individual at an airport, the system is provided with information on the routes people are likely to take. The system understands and absorbs that most people go from the airport entrance directly to the ticket check-in area, most likely then to check the flight information board, and from there to security checkpoints. Because it is designed to detect behavior that differs from the norm, the analytic-based system is intended to pick up someone who follows no logical pattern through the facility. This could be someone who stops and then starts moving again in an erratic pattern. It could be someone who seems to linger in front of doors that are alarmed or marked “employees only,” suggesting that the person might be considering whether it is possible to enter without detection.

Although some transit agencies are making use of video analytics, introducing smart video into the rail environment presents a number of challenges. The major challenge is anticipating patterned behavior. This is more difficult in a transit facility than at an airport, where the most people are boarding or alighting from a plane. At a large urban transit facility, people may be shopping, walking through the station to avoid city streets in bad weather, dining at one of the facility’s sit-down or fast-food restaurants, or doing any number of things that do not involve taking a train. This is less likely to occur at a small, suburban light rail station, where virtually all those on the platform are apt to be waiting for a train, but patterns may still be different if the Monday-to-Friday crowd is primarily commuters carrying only briefcases and the evening or weekend crowd is made up of families taking

rail to a sporting event. Furthermore, even before such systems have become common, the Federal Bureau of Investigation (FBI) released a warning that terrorists may be one step ahead of smart video. A jihad-advocating website reportedly suggested that adherents leave suspicious bags around New York and Washington, D.C., to desensitize first responders by forcing them to respond to suspicious but harmless items left in public areas (Weiss and Mangan 2010).

NJT has used federal DHS funds to install a system that is programmed to alert those who monitor the video when a suspicious activity has occurred. In a station, this might be a bag left unattended or in a particular location. Along the ROW, it might be a boat docked under a bridge (Hecker 2006). Also in conjunction with DHS, MTA-MD has been developing a smart video system in the Baltimore subway system, light rail stations, and in Maryland commuter trains (Nakanishi 2009, p. 23). St. Louis’ MetroLink combines tunnel intrusion with analytics to monitor its tracks and tunnel. The intrusion sensors indicate activity in the area while the analytics are able to determine whether the intrusion is authorized or not (Resnick 2009). Boston’s MBTA is using smart video elements in its recently updated camera network, particularly in and around tunnels. Smart video is also a large component of the National Capital Region Rail Pilot Program involving Amtrak, as discussed in Chapter three. The use of analytics is also a feature of the surveillance systems of two case study agencies, Metro Transit and Valley Metro (see chapter five).

### **Distinguishing the Usual from the Unusual**

Because of the greater focus on airport security than rail security, a demonstration of smart video in late 2009 at airports in the United Kingdom used footage obtained at Heathrow International Airport, where a group of scientists said their prototype identified potential threats that human operators would have missed (Fleming 2009). In a study conducted among Florida transit agencies, Dmitry B. Goldgof and colleagues (2009) found that few agencies were knowledgeable about analytics. The study also referred to a number of drawbacks, including an analytic system’s vulnerability to environmental variables such as detrimental lighting conditions and weather, both of which may lead to false alarms that could become a source of frustration for the user. Another drawback, particularly in environments where not all activities can be anticipated, was that to properly program an analytic system, events need to be predefined; events that have not been defined will not be detected (p. vi).

Announcements on breakthroughs in the area of analytic software appear regularly in the security and technology trade press, which makes it difficult for operations managers to keep up with the changing technology. For instance, in the first 2 weeks of June 2010, researchers announced that a computer vision system that was not yet

ready for commercial use could provide a live text description of video images to alleviate some of the time and labor of searching through video or image collections. Another set of researchers announced the development of software that would also save time and tedium by summarizing a whole day's video in a few-minutes-long synopsis. In the same period, DHS announced a pilot project in conjunction with the Massachusetts Port Authority to test a system at one terminal of Boston's Logan Airport that puts together a number of cameras to provide a 360-degree wide view and can analyze images with sufficient detail to scan for abnormal activity and for suspicious items left behind or removed (Beauge 2010; "Hebrew University Invention ..." 2010; Simonite 2010).

As with the use of surveillance cameras along the ROW and of sensors in conjunction with existing or upgraded video surveillance networks, analytics is a relatively new technology that will undoubtedly receive more attention from transit agencies as it becomes more readily available and as funds become available for additional research and purchase.

#### **ARCHIVING, RETAINING, AND ACCESSING SURVEILLANCE IMAGES**

Agency policies on archiving, retaining, and accessing surveillance system images differ considerably. A majority of agencies (35 of 42 respondents) archive the images from their video surveillance systems, but differences exist in the length of time images are retained. In some cases, this has to do with state laws; Florida, for instance, mandates that images from surveillance systems be retained for at least 1 month.

Archiving images is only one of a series of decisions that need to be made about surveillance systems. Overall, retention ranged from none at all unless something exceptional was observed or reported to more than a year, including up to 3 years in one agency. Access to images is another important policy area with organizational and legal ramifications. Although most agencies indicated that only "designated individuals" could access images, the definitions of these individuals were not consistent.

But despite the differences in policies, certain generalizations are appropriate. In all agencies with their own police departments, police may access the images, although in some agencies access for forensic investigation may be limited to detectives/investigators or supervisory staff members. Agencies with security departments, rather than fully empowered police departments, are more likely to limit access to supervisory personnel. When the security staff is supplied by an outside contractor, only high-level supervisors or agency employees who manage the security staff are likely to be authorized to access images.

Among others listed were risk assessment staff, safety and claims managers, facilities managers, legal counsel, and a variety of rail operations personnel, often in the last instance limited to supervisory personnel. A number of agencies chose not to answer this question. Although it is difficult to interpret this lack of response, it may merely indicate that the person who completed the form is not involved in this area of administrative decision-making. If this presumption is accurate, it indicates a need for policy coordination among all those with responsibility for use and maintenance of the video surveillance system.

An area related to who may access images is what procedures exist to ensure that only those designated with the authority actually have access. To address this area, the survey asked a question on procedures that were used to maintain a record of access (often referred to by law enforcement personnel as the chain of custody). Of the 32 agencies that indicated they permitted only designated individuals to access images, 10 had specific sign in/sign out procedures. Five agencies said that designated individuals were required to access the records only with another person present, and five indicated another control mechanism such as writing in a log. Though "only designated individuals" is likely to be sufficient for internal review, it can be anticipated that particularly in a criminal court case, a more formal sign in/sign out policy will be required to meet chain of custody requirements. Last, there is the question of public access. Of the 41 agencies that answered the question on public access policies, 17 indicated they had none.

The issues of the length of time images are retained, who may access them, and developing a formal mechanism to track access appears to be a fruitful topic for discussion at professional association meetings. Agencies with more formal policies that have had experience relying on their images might share information with less experienced agencies.

#### **VIDEO SURVEILLANCE AS A FORENSIC TOOL**

The importance of policy development surrounding use of surveillance images is directly related to its use as a forensic tool in both criminal and tort (civil) prosecutions. If agencies intend to offer images as evidence in court and in formal internal disciplinary matters, they will be asked to describe how the images are safeguarded, how they are labeled as to location and time, and what chain of custody policies ensure that the images are not tampered with and are actually the ones on which charges were based.

Use of images for criminal or civil prosecutions is common. Thirty-seven agencies indicated that either their own police or local police used images from their surveillance cameras in court cases. This is a large increase over Maier and Malone's 2001 finding that 10 of 19 agencies had used

recordings from their surveillance systems as evidence in court. The increase can be attributed to higher quality images being available from upgraded camera networks and also to courts having become more accustomed to accepting video images as evidence.

The media tend to be intrigued by video evidence. Cases in which it plays a role are frequently publicized widely in local newspapers and on television stations, where the video image is often shown frequently on news programs. Two typical examples include a 2006 arrest made in conjunction with a stabbing that occurred on a GCRTA trolley after the assailant was identified based on video images. At the time, GCRTA said that videos were not viewed in real time at its command center but that drivers were trained to activate the onboard system when an incident occurred to ensure that the data was recorded over (Gural 2006). In a similar incident, in 2009, video cameras in place on an MBTA bus led to the arrest of five people who were charged with assault with a dangerous weapon (Irons 2009). In Philadelphia, police were able to arrest a suspect who is alleged to have attacked a SEPTA passenger with a hammer. Although other passengers ignored the assault, the suspect was later identified after surveillance video that aired on local television resulted in his identification (“Philadelphia Police Make Arrest...” 2008).

In addition to indicating that video had assisted in criminal prosecutions, almost as many agencies (32) reported that they had used images from their surveillance systems as evidence in employee disciplinary actions. The two questions may or may not be related, but of the 39 agencies that reported whether they had seen a reduction in fraud/injury claims based on their surveillance systems, 25 answered yes and 14 answered no. Fraudulent claims may come from a number of sources other than employees, such as “ghost riders” and individuals who claim to have lost items or been injured in some way on the agency’s property.

The relationship between surveillance evidence in disciplinary actions that result in a reduction of internal fraud/injury claims appears to be a fruitful area of further study. A better understanding of whether there is a relationship between the presence of surveillance cameras and employee fraud and/or discipline would be of particular value because the issue of cameras in operator/cab areas has become a prominent and controversial one and is likely to become a labor/management negotiating issue.

As surveillance systems proliferate in public areas, many civil liberties groups have filed or have indicated they are planning to file lawsuits surrounding this. A review of existing laws, pending litigation, and any existing model policies

in these areas would provide guidance to transit agencies and could preclude costly and time-consuming litigation.

#### **PATRON AND EMPLOYEE AWARENESS AND PERCEPTIONS OF VIDEO SURVEILLANCE**

The vast majority of agencies (31 of 41) notify patrons that surveillance cameras are in use. As with record/image retention, whether to notify patrons of the presence of surveillance cameras may be strictly an administrative decision or may be based on state regulations. The U.S. Supreme Court ruled in 1967 in *Katz vs. United States* (389 U.S. 347) that there is no reasonable presumption of privacy in a public place. Following the reasoning of *United States vs. Knotts* (368 U.S. 276) in 1983 that persons traveling on public thoroughfares had no reasonable expectation of privacy, the same applies to transit facilities.

In addition to meeting legal or regulatory obligations to provide signage or other notification, such as periodic announcements on the use of video, signage indicating the presence of video surveillance has been seen by many agencies as a way to enhance patron’s perception of safety and security. In providing examples of the signage used by a number of transit agencies, Maier and Malone (2001) noted that most include phrases such as “for your protection,” “for your safety,” for your safety and security,” or “for your safety and comfort.” Others simply stated that the vehicle was equipped with cameras or that cameras may be onboard (p. 26). Maier and Malone noted that many agencies used the words “may be recorded” rather than “is recorded” because the latter implies that cameras are always operating, which may not be accurate. This may raise legal issues if something were to occur at a time when the cameras were not in operation. Similarly, if signage implies that cameras are monitored, patrons may mistakenly believe that if they have a problem, it is being viewed in real time and that someone will be dispatched to help them.

Patron perception surveys could assist agencies in learning more about whether the existence of surveillance systems leads to less fear among riders. Surveys could also help to determine whether existing signage is properly understood by riders and others making use of transit facilities, yet relatively few agencies report having measured patron perceptions of security since surveillance was installed. A few who had not measured it said it had existed since the beginning of revenue operations and believed their patrons would not be able to make any comparison with how they felt without surveillance. Of the 32 agencies that answered, 12 had measured patron perceptions through surveys or other instruments; 11 of these stated that patrons reported feeling a higher sense of security (Table 15).

TABLE 15  
HAS AGENCY CONDUCTED PATRON PERCEPTIONS SURVEYS

Perception	Yes	No
Measured patron perceptions since surveillance was installed	12	29
Patrons indicate a higher sense of security	11	N/A

*Note:* Figures total 41 responses; two agencies did not respond. N/A = not available.

Only nine agencies had measured employee perceptions of security since the installation of video surveillance technology. Similar to patrons, some employees have worked where such equipment has always existed, which would make it difficult to determine how effective a measure it is of their feelings of security at their work sites or, on the other hand, whether they believe it is there solely to monitor their productivity or adherence to work rules. All of the agencies that had measured employee perceptions said that employees reported a higher sense of security. Agencies were also asked whether unions or employee representatives had been consulted in the decision to install surveillance technology;

of the 31 replies, 22 said no and 19 said yes. On a transit system where virtually all operating employees are unionized, MBTA has included unions and employee organizations in its decision to install surveillance technology, which is used onboard vehicles only in passenger areas. An interesting area of study would be whether older systems or those whose employees are covered by union agreements are more likely to consult with employee representatives. Also, newer systems that included surveillance as part of their initial planning may not have a need to consult with employees because utilization of surveillance does not represent any change in working conditions.

Quantitative data can be useful for agencies to compare their own practices with those of other agencies. Qualitative information, which is generally provided in a narrative format that makes it easy to highlight details and point out lessons learned, can also help agencies to learn from others. Chapter five provides case studies to assist transit professionals who have been and will continue to make decisions on the purchase and use of surveillance systems by comparing their own situations with those of other transit systems.

## CASE STUDIES

### INTRODUCTION

Five case studies were developed to explore various aspects of how systems integrate or expand existing electronic video surveillance into their operations. The case studies provide descriptions of actual decisions that agencies are faced with in planning for installation of video on their rail systems, and attempt to fill a paucity of data on such matters by describing how specific agencies have addressed these and related issues. The case studies are also intended as catalysts for additional research and for discussions among transit agencies to learn from each other. Quantitative research provides a broad overview of industry practices but single-site reportage can more fully address particular aspects of a problem. Formal discussions can highlight recurring problems and successes, and informal discussions among agency managers can provide a forum where missteps are more likely to be shared with the goal of saving others from making similar miscalculations.

Case studies are intended to combine these elements by sharing experiences of specific agencies to assist others in better articulating the needs of their own transit systems. The transit agencies represented are varied enough that almost all systems can take something from them that can be transferred to other venues. The agencies provide geographic, size, and system type balance. They were selected with the goal of providing ideas that everyone can use—some to a greater degree than others—but containing best practices or things to avoid that have a certain universality. The aim is to share information and help to educate transit agencies considering enhancing their video surveillance systems by helping them make informed decisions based on learning from what others have learned. To facilitate making the maximum use of the case studies, each one begins with an overview of the transit agency and its policing/security configuration in order to place the ways in which video surveillance is used and monitored into the larger context of the agencies' overall security goals and protection strategies.

#### **CASE STUDY 1: ALTAMONT COMMUTER EXPRESS, SAN JOAQUIN REGIONAL RAIL COMMISSION, CALIFORNIA**

##### **Description of the Transit System**

The Altamont Commuter Express (ACE) began providing commuter rail service between San Joaquin, Alameda, and

Santa Clara counties in California in 1998, with service provided between the cities of Stockton and San Jose. The system, which is managed by the San Joaquin Regional Rail Commission, comprises 86 route miles and includes 10 stations serviced by 6 locomotives and 24 Bombardier bi-level rail cars, each category of which averaged about 9 years of service in 2009. Railcars include 110-volt AC outlets, restrooms in every car, and a bicycle car. There are bicycle lockers at every station except Fremont. Plans to introduce onboard Internet service were suspended in mid-2009 as a result of economic constraints. The annual ridership is 797,224; annual operating costs are \$16.2 million, and annual capital costs are \$69 million. According to the Bay Rail Alliance, ACE would like to add service but is constrained by the amount of freight traffic because the rails on which ACE operates are owned by the UPRR.

##### **Security Organization and Personnel**

ACE has no dedicated law enforcement agency and does not directly employ any police officers from the local police departments whose jurisdictions it travels through. Two stations fall within the same policing jurisdiction; the others each fall within a different agency's territory. In addition, Amtrak police and UPRR police also have jurisdiction, requiring ACE to coordinate its law enforcement efforts with nine separate police departments. This is in reality a minimum number, as the rail system overlaps two of the UPRR police districts and also falls within two separate TSA districts (Oakland and San Jose).

While these somewhat complicated arrangements could present problems with either over- or under-enforcement, ACE has built personal relationships with each department. Transit managers believe that the system and its passengers receive adequate police coverage. Officers from the local departments ride the trains and are encouraged to patrol parking areas and to make use of station facilities as a way to increase uniformed police presence. In addition, local and railroad police use a recently constructed security kiosk at ACE headquarters as a substation to augment coverage provided by ACE's facility watchman. Wi-Fi is available for first responders to use at the kiosk. In addition, ACE provides a small conference table, chairs, water, and coffee to encourage law enforcement officers to use the kiosk, enhancing the agency's partnerships and providing high visibility at

ACE headquarters. Information not publicly available was provided for the case study by Steven Walker, Safety and Security Coordinator.

### Original Video Surveillance System

ACE initially installed surveillance equipment in 1999 in a number of stations, station platforms, shelters, and parking facilities. ACE is one of the few agencies surveyed that uses onboard cameras in both passenger and operator/cab areas. At the time of the survey, between 80% and 90% of its heavy rail vehicles had onboard surveillance but only three stations (30%) were covered by video cameras.

ACE was able to expand its use of video surveillance in late 2005, when it awarded a contract to A4S Security to install its ShiftWatch® Transportation Video Surveillance system on its trains. The contract called for a minimum of four cameras on each railcar to be set up so that passengers would be recorded as they entered and exited the trains. This earlier installation of cameras was funded through an \$800,000 DHS grant that was part of a \$7.1 million allocation for public transit in the Bay Area and San Joaquin County. The cameras were tied into a wireless Internet connection to make the images accessible to police. Additional enhancements included a GPS-type tracking system to permit ACE officials to monitor the location of each train and a radio system that would allow transit agencies to communicate directly without having to filter their conversations through local law enforcement agencies (Sherbert 2005).

Although ACE had received several small grants since 2007, there is a lag time between when the grant is awarded and when the money becomes available. Also, the grant “sunsets,” meaning that it must be used within a certain amount of time after it is received. The grant may be used only for purchase and for the maintenance warrantee. For a relatively small agency such as ACE, with no police force and only a small number of other specialists, an important factor in deciding whether to upgrade the surveillance network is the recurring cost of running it.

In addition to the difficulties that many transit agencies face in being able to anticipate receiving funds from DHS, ACE is faced with additional question marks. It is the smallest rail agency in the DHS’s Bay Area Regional Transit Security Working Group Tier I area. Other bus, rail, and bus/rail systems in this area include two much larger transit systems, BART and San Francisco’s Municipal Railway; the Golden Gate Bridge; Valley Transportation Authority; and Alameda County Transit. The request for funds by all these agencies consistently exceeds the funds allocated to the region. The allocation of funds within a region depends on a number of issues but because ACE has lower ridership than the larger systems and is not perceived to the same degree as the others as a potential terrorism target, it rarely finds itself at the top

of the funding priorities. In 2009, a total of \$28 million was set aside for the entire region.

### Current and Future Upgrades

In 2009 ACE received about \$500,000 to install a video surveillance system at six of its station platform areas and parking lots as well as in its Robert J. Cabral Station headquarters. About half the funds came from an FTA grant, the rest was from California state funds derived from the passage of Proposition 1B. This case study describes the steps involved in preparing a request for proposal (RFP) to design the system, selecting a vendor, and working with the other rail agencies with which ACE shares jurisdiction at its stations and along its ROW. It is an example of the timeframes and issues involved in managing even a fairly small grant involving installation or enhancement of a video surveillance system.

The Rail Commission was notified in February 2009 that its request for funds had been approved. In late July, an RFP to design the system was released; 21 firms responded to the online solicitation, 9 eventually submitted proposals. An August 2009 pre-bid walk-through of the Cabral, Lathrop-Manteca, Tracy, Vasco, Livermore, and Pleasanton stations was arranged. Ultimately, four of the nine teams were invited to the interview process. On October 2, 2009, the ACE Board approved the hiring of TRC Solutions, Inc., of Irvine, California, to design the system. An RFP for the installation is anticipated to be released during the third quarter of 2010 and ACE anticipates that the equipment will be operational by the first quarter of 2011.

Although the system is not yet operable, planning for it began even before receipt of the grant. One of the first decisions made by ACE was which of its stations to include in its grant proposal. Because ACE works with such a large number of municipalities and has small safety and security staffs, a number of local cities, including Stockton, Ripon, and Los Banos, were contacted to help research what would work best in each area. Decisions included, for instance, whether to purchase a wireless or a hard-wired system. Recurring budget allocations and the quality of the video images played a role in what technology ACE decided on. The system was designed to be scalable to work with fiber-optics in the future, which means that the current system will provide all identified needs at an affordable price. However, ACE believes that when fiber-optics become available, its system will function at a significantly lower cost. Finally, of the six stations selected, three will receive surveillance enhancements and three will be receiving video surveillance technology for the first time. ACE’s original decision was based on stations where ACE had sole service, but Walker worked closely with Amtrak, with which ACE shares Fremont Centerville and Santa Clara Great America stations.

At the time of the case study in summer 2010, ACE was working on a new grant proposal that was effectively phase 2; specifically, a request to add surveillance at two more stations. To date, ACE has received approval for an additional \$300,000 from a FY 2010 Transit Grant Security Program grant that will be used to fund a continuation of the surveillance system and the Fremont Centerville and Santa Clara Great America stations. Although Amtrak owns the platforms at both stations, ACE will fund all of the Fremont Centerville platform and parking facility system costs but only the parking facility at the Santa Clara Great America Station, where Amtrak will assume the platform costs. Because this is a shared project in relation to both funding and use, ensuring equipment interoperability played a large role in the plans for both stations. As designed and offered out for bidding, ACE will be able to view Amtrak's system and Amtrak will be able to view ACE's system. First responders will be able to view everything at all stations.

In addition to working closely with Amtrak and the local communities it serves, ACE also used outside expertise. The system was designed by a consultant who also wrote the RFP and continued to assist the agency after the contract was awarded to TRC, a California firm, based in large part, according to Walker, not only on the firm's understanding of the technical requirements of the new project but also on its ability to work with the existing infrastructure and, most important, the issue of recurring budget concerns. Even with this high level of cooperation and understanding, including regular progress reports, the timeline for the work was longer than originally established. TRC, though, was able to explain why some deadlines originally slipped and were able to stay within the budget.

Despite working closely with its many local and railroad partners, ACE had considered requesting funding for ROW cameras but was unable to develop a partnership with UPRR. Even without the inclusion of ROW surveillance, ACE anticipates that when the work is completed during the first quarter of 2011 it will have a fully functional security surveillance system in place. In addition to stations, the system will cover all employee areas, IT areas, lobby, customer service, bus lanes, and counting room areas. It represents upgrading in a number of areas. For instance, although the existing system recorded on a 24-hour basis, it was not viewed in real time and provided a record of events only. The new system will be monitored from 4 a.m. to 9 p.m., Monday to Friday, by a combined staff of operations center personnel and agency security staff. Hours beyond those will be monitored by the ACE facility watchman and contract security officers in the ACE Operations Monitoring Center. Additionally, because ACE relies on a large number of local police departments, each will have viewing ability but none will have camera control authority, which will remain solely within the agency.

## Lessons Learned

Although in amount of money and time, this case study reports on what would be considered a small upgrade of a surveillance system, to ACE the upgrading required working closely with a large number of partners and will cause a number of internal administrative changes. Under present policies, images were retained for 5 days; under the new system, which will provide a higher quality video image, the images will be retained for 10 days. After formulating new procedures, ACE has decided that the video images will be accessible only to the safety and security coordinator and to IT personnel. A new policy on chain of custody is also anticipated, more clearly delineating those who are considered authorized personnel.

These administrative changes reinforce that surveillance hardware purchases, regardless of the funding sources for upgrading or retrofitting are obtained, require that an agency give advance consideration to how the new network will affect its day-to-day operations and what personnel decisions, and policies and procedures will require creation or revision to complement the new system.

## CASE STUDY 2: METRO TRANSIT, MINNEAPOLIS, MINNESOTA

### Description of the Transit System

Metro Transit is a multimodal system that provides bus, light rail, and commuter rail service to the Minneapolis–St. Paul (Twin Cities) metropolitan area. The Hiawatha Line introduced light rail service in 2004; it covers 12 route miles and 19 stations, including downtown Minneapolis, the Minneapolis/St. Paul International Airport, and the Mall of America in Bloomington, Minnesota, the largest shopping mall in the United States. Fifteen stations are at-grade, three are elevated, and one is underground. The route includes a 1.6-mile tunnel under the airport. The 15 grade crossings are equipped with warning equipment but not with video surveillance.

Trains run in two-car and three-car consists; vehicles are articulated, designed for 66 seated passengers and 187 passengers at full capacity, and are equipped with luggage racks and bicycle storage hangers. Vehicles are bidirectional and are powered by 750 VDC from overhead power lines. Traction power substations are operated automatically from the Hiawatha Rail Control Center. Regular service hours are from 3:40 a.m. to 2:25 a.m.; rush-hour headway is 7.5 minutes. In addition to regular service, airport shuttle service is provided between the two airport terminals; headways are 10 minutes. Traveling the entire line one way takes approximately 36 minutes.

In late 2009, Metro Transit opened its Northstar line, a 40-mile, six-station commuter rail line that operates with 5 locomotives and 18 refurbished passenger cars traveling on BNSF tracks from downtown Minneapolis to Big Lake, Minnesota. Through a perpetual easement agreement with BNSF, Northstar operates 12 trains on weekdays and 6 on weekends and holidays, with provisions for numerous special events trains annually. Northstar connects to the Hiawatha LRT through a four-block extension of the light rail line to reach the downtown Minneapolis commuter rail station. With the exception of the downtown station, all Northstar stations have park-and-ride facilities.

Metro Transit contracts with BNSF for operations and train control. Policing is the responsibility of the Metro Transit Police Department in conjunction with local departments along the alignment. There is video surveillance at the commuter rail platforms and in the parking lots. There are also cameras onboard the railcars recording the passenger areas as well as forward-looking cameras in each locomotive and cab car. None of these cameras are monitored in real time nor are there plans to monitor them in the immediate future.

Planning is also under way for the Central Corridor, a second light rail line that will provide service between downtown Minneapolis and downtown St Paul, traveling primarily in a median of University Avenue, and providing service to the University of Minnesota. The FTA announced approval of funding of this extension in April 2011. The 11-mile Central Corridor will share five stations and 1.2 miles of track with the existing Hiawatha line. New construction will include 15 stations and about 10 miles of track. Plans for electronic video surveillance include covering station areas where TVMs are located, portions of platforms, and all skyways and tunnels. Cameras will be installed in all LRVs, but not in parking lots. As with the existing system, it is not anticipated that cameras will be monitored in real time.

### Security Organization and Personnel

Metro Transit's police department is in transition. Currently, it is an unusual combination of a fully accredited in-agency police department and part-time officers from other agencies. The police department was formed in 1993 after receiving legislative approval. For almost a decade, it employed only supervisors who oversaw about 175 local police officers who worked part-time for the transit system while working full-time for their home departments.

In 2002 the agency decided to convert to a traditional, full-time transit police department made up of officers employed solely by Metro Transit. The department now employs about 70 full-time Metro Transit officers and about 50 part-time officers from other departments who continue to work a number of tours of duty on the rail line. Chief David H. Indrehus, whose official title is Director of Secu-

rity and Police Services, reports directly to the general manager. Information not publicly available was provided for the case study by A.J. Olson, Deputy Chief of Police.

### Hiawatha's Original Video Surveillance System

Despite opening for revenue service with a well-designed video surveillance system, Metro Transit has been upgrading its system almost since its inception. The initial system was based on almost 130 cameras that were installed at the 17 original stations and two parking lots. The at-grade and elevated stations have canopies and windscreens and overhead radiant heaters. Each station is furnished with emergency call boxes, maps, information kiosks, public art, and benches. Fare collection is a self-service, barrier-free proof of payment system that is checked periodically by Metro Transit police officers. Each station, with the exception of large facilities (i.e., Mall of America, Lindbergh Airport Terminal, and Lake Street Station) was designed with four cameras per station. Cameras also monitored the portals into the tunnels on S. Hiawatha and Minnehaha and at the airport. With the exception of one pan-tilt-zoom camera (Figure 5) at Fort Snelling, all others were fixed-position cameras.



FIGURE 5 Fixed cameras (top) are being replaced with pan-tilt-zoom (PTZ) cameras (bottom). PTZ cameras provide greater surveillance coverage because they can pan (move left and right), tilt (move up and down), and zoom in or out. Photos courtesy of Metro Transit Police.

Each LRV was equipped with four onboard cameras for digital recording but without audio capability. Other emergency and communication systems include a Supervisory Control and Data Acquisition System (SCADA) to monitor train location, track, systems, and alarms, and a radio system that is compatible with regional emergency services radio networks. Radio service is available on the LRVs; at the Rail Control Center; and through rail supervisors, maintenance personnel, and police personnel.

All camera feeds were initially routed to the Rail Control Center, located at the Rail Operations and Maintenance building through fiber-optic cables for recording on eight VHS tape decks with 16 cameras recorded on each tape with the use of a multiplexer. This was found to be unsatisfactory because it resulted in extremely slow frame rates on each camera (more than 1 or 2 seconds between frames), which resulted in the loss of a great deal of video evidence as the multiplexer scrolled through its assigned cameras. In addition, the four onboard cameras were recorded only on the vehicle; they lacked remote viewing capability. This created inefficient retrieval of video because the hard drive had to be removed from the vehicle and manually downloaded for viewing. The cameras also lacked the resolution to identify individuals well enough to be considered forensic tools; specifically, identifications were not clear enough to be used to positively identify a suspect's image.

Attempts to solve these problems led to system upgrades in 2005–2006. At that time, camera lenses were upgraded to “auto-iris” lenses, which improved video quality in all lighting conditions by automatically adjusting to available light rather than having to predetermine a setting that compromised between ideal day and night settings. A year later, in 2006–2007, two of the four fixed cameras at each platform were replaced with pan-tilt-zoom cameras.

In 2007, DHS TSGP funding led to a major upgrade to a digital, server-based system. This allowed for continuous recording of all cameras with adjustable frame rates; images per second were increased to ten IPS to eliminate loss of video, which also improved image quality significantly and made the review and retrieval of video less time-consuming. About 3 years ago, Metro Transit became one of the first transit agencies to incorporate video analytics into its surveillance network, installing it at tunnel portals to supplement its intrusion detection system. The video analytics were purchased with DHS TSGP funding as part of the project to implement the digital, server-based video recording system. The analytics are designed to “recognize” rail vehicles and allow them to pass without notice. However, if something else accesses the portal, including pedestrians, animals, or a vehicle of another configuration, or even garbage blown by the wind, the video monitor above the rail control supervisor's console will immediately switch to the affected camera view accompanied by an alarm. The supervisor has the abil-

ity to immediately play back the video to see what activated the alarm. This system is employed in addition to another intrusion detection system that is also designed to recognize a non-LRV intrusion.

### **Current and Future Upgrades**

Metro Transit is continuing to upgrade and retrofit. In 2007–2008, again with DHS TSGP funding, a larger hard drive and forward-facing cameras were added to the system on the LRVs. In a project still under way, beginning in 2008, the extension of LRV station platforms to accommodate three-car consists required that at least one camera be added to each platform. Since 2009, and ongoing depending on available funding, Metro Transit plans to replace two fixed cameras at each location with megapixel cameras.

Other upgrades are also under way; virtually all involve DHS funding. These include installing a wireless mesh network along the alignment to allow for real-time monitoring of LRV cameras; providing the capability for wireless downloading of LRV video at the Operations and Maintenance building, which will eliminate the need to physically remove hard drives from the LRVs to download video, and upgrading software to a digital recording system to make it a true network digital recording system. The last improvement is being funded as part of the Central Corridor light rail transit expansion because it will make expanding the recording capacity easier and less expensive in the future.

### **Lessons Learned**

As a new light rail system, Metro Transit was able to incorporate virtually all recommended CPTED features into its stations, station platforms, and shelters and parking facilities. In addition, onboard surveillance was an integral part of the overall safety and security program. Despite this, certain inadequacies were recognized almost immediately. Problems are often magnified when newer technology raises expectations, for instance in the quality of video images and the belief that all images can be used for positive identification. Even with a steady funding stream, something agencies cannot rely on, the speed at which new features of surveillance systems become available makes it virtually impossible for transit agencies to keep pace with changes.

Metro Transit has been successful in obtaining funds. Its DHS grants have totaled in excess of \$1 million. However, competing for funds requires time and expertise. The application process requires not only understanding funding requirements and deadlines but also having available individuals with the technical knowledge to know what to request. Additionally, although vendors are now aware of the needs of transit agencies—particularly video systems that can operate under varying lighting conditions and provide sharp images that can be easily downloaded and

accessed—newer technology will create a need for ever-advanced systems.

Although it is a pioneer in the use of analytics, Metro Transit experiences have shown that there is a constant need to review an existing network. The need to retrofit is more often associated with far older transit agencies, but Metro Transit's experiences with the need to constantly upgrade its surveillance capabilities reinforces that the need to stay current is as important an issue for new systems as for far older rail lines.

### **CASE STUDY 3: METROPOLITAN TRANSIT AUTHORITY OF HARRIS COUNTY, HOUSTON, TEXAS**

#### **Description of the Transit System**

The Metropolitan Transit Authority of Harris County in Houston, Texas, known as METRO, began operations on January 1, 1979, as a regional transit authority to provide bus service to metropolitan Houston and surrounding areas. In November 2003, voters approved Metro Solutions, a plan for multimodal transportation improvements that included development of 30 miles of light rail transit. At present, METRORail's Red Line is a 7.5-mile light rail system that runs between the University of Houston-Downtown to south of Reliant Park along three major streets. Eighteen LRVs travel at grade, sharing streets with other vehicles. Powered by an overhead catenary system, the LRVs provide service to 16 stations, most located near major city facilities, including the museum district, the Houston Zoo, and the Texas Medical Center.

Trains operate from 4:30 a.m. to 12:45 a.m. Monday through Thursday; 4:30 a.m. to 2:15 a.m. Friday; 5:30 a.m. to 2:15 a.m. Saturday, and 5:30 a.m. to 12:45 a.m. Sunday. METRORail also serves the Bush Intercontinental Airport by means of a bus every 30 minutes. In addition to the rail and local bus service, METRO also has a commuter bus system that provides high-passenger capacity service to suburban patrons by bringing them into downtown Houston through one of the five METRO high-occupancy vehicle lanes.

METRORail parking is provided at the southern-most end of the light rail line. It is managed through a public-private partnership; METRO supplies the infrastructure, which includes video monitoring, and the private firm manages the fee collection. Parking for the commuter service is available at a total of 27 parking facilities (known locally as park-and-rides) located at various points along the line.

#### **Security Organization and Personnel**

The METRO Police Department was formed in 1982; at that time, METRO was one of only a handful of bus-only sys-

tems that maintained its own police department. It is also the only transit agency whose police officers are responsible for enforcement of laws and regulations pertaining to the highway system's high occupancy vehicle lanes. All traffic control and enforcement efforts are monitored at the METRO command center located at police headquarters in downtown Houston and at the regional transportation and emergency management center known as TransStar.

The police department originated as a small group of security guards; soon officers were commissioned as Texas peace officers with full police powers. The department, under the leadership of Chief Thomas C. Lambert, whose formal title is Vice President and Chief of Police, contains 185 police officers and 88 non-sworn civilian employees, about one-quarter of whom are system safety professionals. The department has been accredited by the Commission on Accreditation for Law Enforcement Agencies since 2001, and it is one of only five transit police departments with this accreditation. It was also recently rated in the top 5% of mass transit agencies in an assessment conducted by TSA. The majority of the department's employees are located at the Buffalo Bayou facility in Houston's Central Business District. Police communications and dispatch personnel work at TranStar, located near the Katy Frwy/610 interchange.

METRO police officers work within the 1,285 square-mile METRO service area. They are responsible for METRO facilities, and vehicles and equipment. They respond to calls for police service and investigate crimes that involve METRO or occur on METRO's facilities, which include, in addition to the light rail line and LRVs, 26 parking lots, 20 transit centers, the 1900 Main administrative headquarters, the Rail Operations Center near Reliant Stadium, nine bus operating facilities located throughout the service area, the more than 13,000 bus stops and shelters, and all buses. Teams of officers are assigned full time to ride buses and LRVs in uniform and in plainclothes to enhance passenger safety by observing and arresting persons who commit crimes such as operator assaults, robberies, thefts, or narcotics violations on the transit system.

Watch Command Officers at TranStar monitor the surveillance cameras installed at park-and-ride lots and transit centers. Bus cameras are not monitored in real time. For those cameras that are monitored in real time, when suspected criminal activity is observed the officers dispatch roving officers to the scenes of the incidents. The video that is collected from aboard camera-equipped buses is reviewed after an offense to aid in prosecution. Another METRO police division designed to keep traffic moving is the Motorist Assistance Program. Civilian employees drive marked pick-up trucks with extra gas, jumper cables, and other equipment to help motorists using the high occupancy vehicle lanes along the expressways.

Other police operations include K-9 teams trained in narcotic or explosives detection, a first-responder Special Operations Response Team, motorcycle officers, and explosives ordinance disposal technicians, as well as several officers assigned full time to the Houston Crime Stoppers office, the Houston Police Department's Auto Theft Division, and the Houston FBI Joint Terrorism Task Force. Information not publicly available was provided for the case study by Sgt. Felix Vara.

### **Existing Surveillance Technology**

METRO's use of video surveillance developed in piecemeal fashion. First introduced at a number of employee facilities in 1982, it was extended to LRVs in 2004, park-and-ride lots in 2007, and buses in 2008. This pattern differs from many other multimodal systems, where surveillance technology has been introduced on buses and only later expanded to railcars. The existing network relies on almost 650 cameras, almost 400 of which cover parking facilities, 130 monitor employee facilities, and 34 are installed on METRORail. Park-and-ride video was supported by an FTA grant. The majority of other cameras were funded from local sources, although DHS funding contributed to cameras on buses.

Onboard cameras covering both passenger and operator/cab areas are installed on all LRVs. In addition, fixed cameras located at rail stations are focused on the paid fare zones. Not all cameras are monitored at all times; park-and-ride lots, headquarters, and employee facilities cameras are monitored only during hours of operation. These cameras have provided video of sufficient quality to aid in the prosecutions of numerous burglaries and of motor vehicle theft suspects. In addition to cameras at METRO facilities and on LRVs, about one-third of the bus fleet has onboard cameras. The video obtained from onboard the buses has also assisted in a number of prosecutions, most often of suspects accused of having assaulted patrons or bus operators. METRO has also found these cameras particularly effective in monitoring a number of safety and risk management-related problems.

### **Current and Future Upgrades**

METRO is currently considering a number of expansions of its video surveillance system that include upgrading equipment but also using surveillance to enhance both its law enforcement and accident prevention efforts. In keeping with advances in camera design, METRO has decided that all new purchases will be of pan-tilt-zoom cameras. The agency hopes to eventually phase out all fixed-position cameras except in locations where these older-design cameras are more feasible. METRO is also exploring expanding its use of video technology in place of or in conjunction with existing perimeter defense such as gates. This change is based on the agency's belief that video will provide less porous protection while also providing investigatory support, something that static perimeter protection mechanisms lack.

METRO is also exploring other ways to expand its investigative capabilities through better use of video technology. For instance, the police are working closely with risk management personnel to enhance protection of park-and-ride lots. In addition to providing greater protection to patrons, transit administrators believe that this will help the agency reduce monetary claims based on injury or loss or damage to private vehicles. One expansion under review is possible because the software used to support the images provided by the cameras in park-and-ride lots is also capable of license plate recognition. With this application, METRO police officers would be able to identify the owner of a vehicle or to determine if the vehicle had been used in criminal activity elsewhere, prompting a higher level of vigilance.

In addition, METRO is considering expanding its use of video cameras at bus transit points, and partnering with the City of Houston on a homeland security video initiative that would add cameras at additional points along the transit system. This system would rely on wireless cameras, which would minimize the expense of wired connectivity and would capitalize on METRO's existing fiber-optic cable infrastructure. In addition to the savings this would represent for the city, these newer-model cameras are portable and could be moved to various transit system locations. Portability would assist criminal investigators because they would be able to analyze crime data and concentrate video surveillance on areas where incidents are occurring, the so-called hot spots of transit criminal activity. METRO sees this as particularly useful for focusing its surveillance efforts on bus stops and shelters. Because these are generally located on city streets, preventing incidents from occurring benefits both the city and METRO. The mobile cameras may also be employed at LRV stops and, as the system expands into less dense areas of the city, at locations that might be less likely to be regularly patrolled by city or METRO police officers.

### **Using Analytics to Prevent Traffic Accidents**

METRO is studying the use of an innovative analytics system to monitor nontransit vehicles making left turns into the LRVs' alignment. The new system has the ability to monitor vehicle movement on a 24-hour, 7-day basis and to report where these actions are occurring, minimizing manpower needs and providing information for directed enforcement.

The system is deceptively simple. A test video shows a number of cars making turns that require crossing over the LRV tracks. Vehicles turning properly are displayed in green (the "go" indicator of having the right-of-way) and those turning improperly are displayed in red (the "stop" indicator of being expected to yield to other traffic). Plans include an enforcement effort that will include officers dispatched to issue summonses to offending drivers. METRO is also exploring the possibility of having summonses issued automatically, similar to red-light and illegal-turn camera

enforcement. Summonses would be mailed to the registered owners of offending vehicles based on photos of the violations.

METRO anticipates that this system will assist in accident prevention and investigation. In addition to assisting in enforcement activities, reviewing where and when violations occur will permit the agency, likely in conjunction with the city, to install additional traffic enforcement devices as well as signage that could assist in accident prevention efforts. The transit agency is responding in part to local concerns about the high number of accidents between LRVs and other vehicles since rail service was initiated. Although the accident rate has fallen considerably in recent years, it was initially far higher than the national average for similar street-running rail systems. By 2007 there were fewer than 20 accidents, down from a high of 60 in 2004.

A number of safety improvements, including new signage, better signal layout, public education, and media attention to the problem, contributed to reducing the number of incidents involving road vehicles and LRVs. The use of analytic video adds another layer of protection to riders in both the railcars and other vehicles as well as to pedestrians, who may also be injured if accidents occur (Figure 6).



FIGURE 6 The photo represents Houston METRO's plan for installation of video analytics to detect illegal left turns by road vehicles into the LRV's right of way. *Photo courtesy of METRO Police.*

### Lessons Learned

Although METRO is not the only transit agency that is turning to analytics as a risk mitigation strategy, it is an example of how working partnerships with local government can bring these innovations closer to fruition. Street-running rail systems are faced with traffic and pedestrian concerns that do not exist for commuter or heavy rail systems. These issues, while presenting unique accident-prevention problems, also present greater opportunity to partner with local government, which must also respond to complaints from the public over street-level accidents and traffic congestion.

Responding to the same concerns, Valley Metro in Phoenix (see Case Study 5) has used its external vehicle cameras

to assist in determining problems at grade crossings. The existence of video also helped to establish culpability in Boston in April 2010, when a sports utility vehicle was hit by an MBTA trolley while making a U-turn across the tracks. In this instance, the accident received widespread publicity because the vehicle was driven by a member of the Boston College national championship hockey team. The driver was charged by police in part based on video of the incident ("Boston College Players' Crash..." 2010). These examples, combined with its own experiences, illustrate why METRO sees video analytics as a way to reinforce its accident mitigation strategies. These examples also show how transit systems, particularly street-running light rail systems, are returning to and updating the earlier uses of surveillance primarily to control traffic and risk rather than seeing it primarily as a crime prevention tool, the use that has become more prevalent in recent years.

METRO's interest in working with the city administration on the mobile camera project and on its own left-turn analytics project that will aid in traffic enforcement also reinforce the importance of recognizing the collaborative possibilities that are open to transit agencies. Such opportunities, particularly light rail systems that literally share the streets with vehicles and pedestrians, open possibilities for identifying mutual concerns over traffic congestion and management and for participating with local government in determining appropriate operational responses.

Such collaborations have important future implications. For METRO, with extensive expansion plans that include an additional 30 miles of track, partnering with Houston may help it to convince smaller communities along the alignment to participate in similar upgrades and to provide the transit system with a way to minimize public complaints and financial claims stemming from traffic-related matters. Given the opportunity, other transit agencies may recognize areas in which they, too, can benefit from working more closely with the localities through which they travel.

### CASE STUDY 4: PORT AUTHORITY OF ALLEGHENY COUNTY, PITTSBURGH, PENNSYLVANIA

#### Description of the Transit System

The Port Authority of Allegheny County (PAAC) is a multimodal transit provider of bus, light rail, and paratransit in a 730-square-mile area that includes the city of Pittsburgh, all of Allegheny County, and limited portions of Armstrong, Beaver, Butler, Washington, and Westmoreland counties. In addition to its transit system, known locally as the T and comprising a 25.2 mile subway and light rail system, it operates an extensive network of more than 1,000 buses, including three major bus rapid transit busways, the first of which opened in 1977 and the most recent in 2000.

As with Minnesota's Metro Transit, it is currently expanding its LRT system.

Pittsburgh's streetcar service began in 1902 but was eventually abandoned by Pittsburgh Railways, which replaced it with bus routes. PAAC was created by the state in 1956, initially focused on port facilities. By the end of the decade it was authorized to acquire privately owned transit companies, including bus lines and two funiculars (incline-plain railways), both of which were constructed in the 1870s. The Monongahela Incline, a 630-ft, two-car funicular, is operated by PAAC; the two cars of the 800-foot Duquesne Incline are owned by PAAC but operated by the nonprofit Society for the Preservation of Duquesne Heights Incline. In addition to providing local transit service, the funiculars are area tourist attractions.

Construction of the T began in the 1980s. In July 1985, the downtown subway opened for revenue service; other sections opened in 1987 and in 2004. The system operates more than 80 LRVs; the vehicles require three floor-level doors per side because of the mix of high- and low-platform stations. There are 24 high-level platform stations, four downtown subway stations, and 37 street-level stops. Stations are equipped with bicycle racks (although bikes are permitted on LRVs only on weekends), electronic message boards, a public address system, telephones and benches, and surveillance system coverage. The T travels through downtown Pittsburgh as a subway with three underground stations (Steel Plaza at Grant Street, Wood Street, and Gateway) and an aboveground station at First Avenue. The downtown loop is free and features classical music and whimsical artwork. The remainder of the system is not free. The T travels across the river to Station Square on the South Side. After going above the Monongahela River, the transit vehicles run above ground along three different light rail lines that travel into Pittsburgh's south suburbs. Major stations also serve as bus-transfer points into downtown Pittsburgh.

Construction is currently ongoing for the North Shore Connector, a light rail extension that will extend the transit system by about 1 mile. Although the distance covered by the extension is fairly short, constructing and protecting is complex because it will travel underground from the Gateway Station, under the Allegheny River in twin-bored tunnels, to the north shore, providing service to newly developed residential and business areas; to PNC Park and Heinz Field, two major professional sports venues, and to a newly constructed casino. Construction of the connector necessitated closing the original Gateway T Station to make room for a new Gateway Center Station. The new line is expected to open for revenue service in March 2012. As with Houston's METRO, PAAC anticipates additional light rail expansion, including service to Pittsburgh International Airport, which also operates under its auspices.

## **Security Organization and Personnel**

The Port Authority Police and Security Services Department was formed in 1968; it is responsible for all PAAC patrol and investigative functions. Recognized as police within the state of Pennsylvania, officers are commissioned in the name of the governor and are authorized to take all police action on and adjacent to PAAC property as well as throughout the Commonwealth of Pennsylvania when on PAAC business. The leadership of the department has been stable; the current chief, Stephen McCauley, is only the fourth person to lead it. He had been the assistant chief under his predecessor, William McArdle. McArdle, a retired FBI agent who grew up and worked in Pittsburgh, joined PAAC as its chief in 1994 and retired in 2006.

The department grew from fewer than 20 officers who also contracted with the county sheriff's office to its current size. It remains one of the smaller dedicated transit police departments, composed of about 40 sworn officers augmented by approximately 12 security guards. In addition to responsibility for patrol in uniform and plainclothes and investigations of past crimes, a number of officers are trained in a variety of police specializations, including accident reconstruction. Since 2004, the department has included a canine unit of specially trained dogs working with their police officer handlers on both routine patrol and for explosive detection. Officers have been trained to staff an Emergency Services Unit, and about one-third of all officers have received specialized training in handling chemical detection and hostage situations, and responding to active shooter situations on buses and railcars. Information not publicly available was provided for the case study by Chief McCauley.

## **Existing Surveillance Technology**

All underground stations are currently equipped with video cameras on all levels that are monitored by the PAAC police. At the time of the case study, in mid-2010, PAAC was anticipating that the existing cameras would be upgraded by the end of the year to video over Internet protocol service. Beginning in 1985–1986, black-and-white fixed-position cameras were installed in all subway stations, and various upgrades and expansions have been undertaken as funds became available. Red telephones labeled "Emergency—Port Authority Police" are located in all stations. Other safety and security features include glass panels in elevator doors for two-way visibility. LRVs are equipped with two-way radios with direct communication with the Operations Control Center, a buzzer system to alert patrons that doors are closing, and a number of features to aid emergency evacuations. Fewer than half of all stations, station platforms, and shelters are currently monitored by surveillance cameras. Cameras are also employed to protect storage and other yards. All cameras are monitored on a 24-hour, 7-day-

a-week basis by a combined staff of police dispatchers and rail operations staff.

A DHS grant of about \$160,000 was used to mount chemical/radiation-detection sensors in a number of downtown stations in 2006 and 2007. Similar to fire or smoke detectors, the sensors monitor for various chemical agents or gases and send an alert to the Operations Control Center and the county's emergency operations center. Because of its growing reliance on computers, sensors, and surveillance cameras, since 2006 the police department has added computer and video forensic specialists to its staff. McCauley noted that because grant funds are generally available only to purchase equipment, agencies must add the salary and related costs of hiring and training specialists to the costs of system upgrades.

As for all the case study agencies, financial issues such as these are important to PAAC. DHS categorizes PAAC as a Tier II agency. Although it is the only Tier II agency in the designated Pittsburgh Area, there are a number of larger Tier I agencies located in the Philadelphia area Urban Areas Security Initiative, including NJT, SEPTA, the Pennsylvania Department of Transportation, the Delaware Transit Corporation, and the Delaware River Port Authority. Although PAAC does not compete against these Tier I agencies directly, DHS funds are not unlimited. To achieve maximum funding, grant development and writing efforts involve a number of PAAC offices. The police department works closely with the system safety department and receives grant writing assistance from specialists within the agency. The process is complex and time consuming; funds are generally not received within the 1-year grant cycle, which means that if the agency hopes to obtain future funding, it must plan a series of upgrades that can enhance the entire network but can be done somewhat independently of one another. PAAC has been successful in its grant applications. McCauley estimates that 80% of its surveillance system funds have come from DHS and the other 20% from agency funding. The funds have been used to upgrade monitoring and dispatching and increase the size of the facility from which video is monitored, in part in anticipation of future expansion of both the transit system and the surveillance network.

In 2007, PAAC received close to \$1 million from DHS to add fencing at a number of facilities; deploy additional digital surveillance cameras, primarily at four busway stations; and provide training to staff on terrorism prevention. The funds were the third-largest grant nationally to similar-sized transit agencies and completed the second phase of PAAC's earlier security upgrade by adding the chemical/radiation recognition equipment. Including the 2007 grant, up to that time PAAC had received about \$4.3 million from DHS, which, according to Steve Bland, the authority's chief executive officer, was a significant amount for a city of Pittsburgh's size (Grata 2007).

## Current and Future Upgrades

The current ongoing project involves upgrading and extending surveillance technology to depots, garages, and storage areas. Part of this plan involves bringing all the new and existing technology together into one smoothly functioning system. Although DHS funding is for antiterrorism installations and upgrading, PAAC's internal grants review committee considers projects that are not all video-surveillance-based. For instance, members of the review committee from operating departments may be interested in obtaining funds for high-speed doors for railcars, security fencing, or upgrading the agency's communication network (which formed the basis of the FY 2010 grant request). In addition, the agency's operating plans include surveillance in patrol and operator/cab areas for all new vehicles and surveillance cameras in all new station design plans, a plan that has been implemented for all North Shore Connector stations.

PAAC has received between \$8 and \$9.5 million in grant funding over the past decade. Although the transit system has never been placed on a terrorist alert, as with other transit systems, PAAC has used the funds to enhance day-to-day security and crime prevention efforts on the transit system and in areas near stations with cameras. As in cities around the country, news media have become more attuned to the use of video surveillance in criminal apprehensions. In May 2010, PAAC police were reported to be viewing surveillance video from a city camera to investigate vandalism to vehicles in a park-and-ride lot where transit cameras had not been installed. Seven weeks later PAAC cameras on a downtown trolley were used to arrest one of Allegheny County's most wanted fugitives who he was spotted on the transit system and was taken into custody when he detrained ("Allegheny County Fugitive..." 2010; Harding 2010).

Pittsburgh is one of a number of cities, including Chicago, New York, and Baltimore, where municipal officials have begun to speak out about their desire to increase the use of video surveillance to protect against terrorism but also against routine crimes. As with Chicago's Mayor Daley and New York's Mayor Bloomberg, Pittsburgh's Mayor Luke Ravenstahl has made the installation of surveillance throughout the city a high priority of his administration. His efforts have received less national publicity, but apart from PAAC funding requests, the city, with the Community College of Allegheny and Carnegie Mellon University, has asked for about \$14 million from the federal Broadband Technology Opportunities Program. In addition, since 2009 the city has used its own \$2.4 million DHS grant to install cameras near waterways, ports, and rivers, and in high-crime areas. It has augmented the DHS funds with about \$860,000 of local matching funds. The city owns only 22 surveillance cameras, but the mayor has publicized its access to about 300 cameras owned by PAAC, the Pennsylvania Department

of Transportation, and private businesses. Smaller communities in the immediate area have also approved funds for surveillance cameras (Brandolph April 9, 2010; Brandolph April 22, 2010).

Despite the existence of a 10-page policy that addresses privacy issues relating to the cameras, the mayor's plans have drawn criticism from the American Civil Liberties Union and others who oppose the cameras on the basis of costs and civil liberties issues, or on research questioning their value in crime prevention (Wilkinson 2010). One critic noted that neither the Port of Pittsburgh Commission nor the local Coast Guard installation reported a single threat against Pittsburgh's waterways or port facilities (Levine 2008). Each municipality that has so far publicized a desire to rely on video surveillance to fight crime has been criticized by local civil liberties groups. Additionally, by focusing on surveillance technology as a crime-fighting tool, these municipal officials have led the media to inquire after almost all crimes about whether video exists from the crime scene. Each of the cities also includes within its borders well-established transit agencies that make use of video surveillance and that rely to differing degrees on DHS funding for system expansions.

### **Lessons Learned**

These ongoing and fluid situations raise questions that are important to transit agencies. Not yet lessons learned, they are more appropriately items for long-range consideration. For instance, transit agencies, particularly those that compete for Tier II funds, may be competing for DHS funds not only with other transit agencies but also with the cities in which they are located. Although the DHS funds come from different grant programs, questions may arise as to whether funds to a municipality may influence awards to the city's transit system. This may lead to transit agencies giving greater consideration to partnering with their cities, as in Houston, by seeking funding for surveillance improvements as upgrades as part of municipal planning but may present problems for transit agencies that overlap a number of political jurisdictions.

Apart from funding, it is difficult to predict the outcome of greater attention being paid to video surveillance as a crime prevention and apprehension tool. Although this increased focus on video surveillance may assist transit agencies in expanding their use of the technology and win them support from external stakeholders who are more concerned with crime than with terrorism, it may also cause the agencies to become embroiled in civil liberties debates surrounding the use of video surveillance. Expanded use of surveillance solely as a crime control tool also may undercut the ability of transit systems use of it to enhance their fraud control and risk mitigation efforts.

## **CASE STUDY 5: VALLEY METRO RAIL, PHOENIX, ARIZONA**

### **Description of the Transit System**

Valley Metro Rail, known as METRO, is a 20-mile at-grade light rail system connecting the cities of Phoenix, Tempe, and Mesa. Costing \$1.43 billion to build, it began revenue service in December 2008, operating from 19th Avenue and Bethany Home Road in Phoenix, continuing through downtown Phoenix and downtown Tempe to Main Street and Sycamore in Mesa. Valley Metro has 28 stations; the major activity centers it serves are downtown Phoenix, the Sky Harbor Airport, Papago Park Center, Arizona State University, downtown Tempe, and Mesa. Eight parking lots provide a total of 3,600 spaces. Most of the embedded track is in streets, separated from traffic lanes by a nominal 6-in curb. Direct fixation is used to attach rail on bridges, and tie and ballast is used in the Operations and Maintenance Center yard, located in Phoenix.

Fifty electric-powered LRVs can be operated singly or as two- or three-car trains by means of an overhead contact wire (catenary) at 850-volts DC that receives power from the two electric companies at traction power substations, located approximately every mile along the alignment. Operating headway is 10 minutes during weekdays, increasing to 15 to between 20 and 30 minutes during off-peak and on weekends. The system operates approximately 20 hours per day. The Operations Control Center, located in Phoenix, is adjacent to the Bus Control Center.

A proof-of-payment system is used to collect fares. Paid areas are indicated by signage and compliance is reinforced by periodic inspection conducted by contract security personnel. Paid areas, sometimes called fare paid zones, are the areas, generally station platforms, where patrons are expected to have valid tickets and may be asked by transit personnel to show a ticket, a receipt, or some other proof that they have paid for travel. Although the agency estimates its evasion rate at less than 1%, it believes it will improve its capability to discourage nonpayment by upgrading its system of manually verifying the identity of riders with an electronic system that will be tied to a database of past evaders.

### **Security Organization and Personnel**

Valley Metro relies on an unusual two-pronged arrangement to secure its transit system. All three cities support the transit system by having their officers respond to calls for service, but only the Phoenix Police Department (PPD) has a transit bureau that routinely assigns sworn officers to transit facilities within its jurisdiction. Phoenix also provides department-employed police assistants, primarily as fare inspectors, whereas Tempe and Mesa have chosen to rely on

the same contract security firm for those tasks. In addition to fare inspection duties, the contract security firm, responsible to the transit agency rather than the individual cities, also patrols stations, platforms, and park-and-ride lots. Patrols include riding the trains, responding to calls by means of dispatched patrol cars, and patrolling stations on personal transportation devices (Segway). Approximately two-thirds of the system is within the city of Phoenix and the PPD is responsible for security only within its citywide jurisdiction. Similarly, the security contractor is responsible for security for only the remaining third of the system, specifically within the cities of Tempe and Mesa. (This comprises only about 1 mile and one station, which is at the east end of the line in Mesa.) PPD also provides municipal security guards to staff the Operations and Maintenance Center. Information not publicly available was provided for the case study by Larry Engleman, until recently the director of the Office of Safety, Security and Quality Assurance, who has remained with Valley Metro as its safety and security consultant.

#### **Original Video Surveillance System**

Valley Metro began planning its security system, including video surveillance, almost as soon as it began planning the overall transit system. Beginning with the formation of its Fire Life Safety and Security Committee in 2001, Valley Metro encouraged area police and fire officials—especially those from Phoenix, Tempe, and Mesa—to get and stay involved. The committee was active, with more than 50 meetings during the years of planning, and benefited from stability in its membership and the CPTED expertise within the group. This advanced planning resulted in all facilities and vehicles being designed using CPTED principles. Stations were built to be open so as to minimize areas for criminals to hide, individual seating is provided to discourage lounging and loitering, and seats on LRVs face the doors where possible so patrons are aware of the movement of other patrons. Specifications to manufacturers call for vandal-resistant materials of smooth nonporous surfaces and cut-resistant fabrics. Plastic film covers all windows and other glass surfaces for easy replacement if marred by graffiti or scratchiti.

Video surveillance cameras have been an integral part of safety and security since the introduction of revenue service. All eight parking lots (referred to locally as park-and-ride lots) are covered by surveillance cameras that are monitored locally and at the control center, which is itself monitored by surveillance cameras. Cameras also cover station platforms and focus on emergency call boxes, which can be helpful if they are engaged and those trying to reach the control center are for any reason incapacitated. This type of surveillance of call boxes is also useful in preventing improper use; for instance, someone might use the phone to initiate a false emergency call as a distraction for criminal behavior. Emergency call boxes are also equipped with local audi-

ble and visual alarms to further discourage misuse. Other emergency and communication systems include a public address system and variable message boards at stations and a SCADA system that monitors train operations and supporting subsystems.

Surveillance is also in place at the Operations and Maintenance Center yard, where it is used to support perimeter fencing and access control at administrative areas. Security is tight at Valley Metro's administrative offices in downtown Phoenix. Electronic locks and key cards provide access control; employees need to display their ID cards at all times, and all visitors must be signed in and are issued visitor ID cards. All areas that are accessible to the public are under camera surveillance, primarily for use as post-event investigatory tools.

In addition, all LRVs are equipped with a larger number of cameras than in many other transit systems. Of the 16 cameras, all continuously recording, 10 cover the exterior and 6 cover the interior of the rail cars. If a passenger uses an onboard emergency intercom to contact the operator, the nearest camera is activated on the operator's console so that the operator can assess conditions. The external cameras play a large role in accident investigation, particularly LRV and passenger vehicle collisions. For example, video removed from an LRV in early 2009 had recorded crossing arm activity that assisted in determining the cause of a collision between a truck and that LRV. The information was also used to check conditions at four similarly designed grade crossings ("Status of Metro Investigation..." 2009).

#### **Protecting the Tempe Town Lake Bridge**

A major element of the surveillance system, and a particular focus of Valley Metro's safety and security program, is the 1,500-ft bridge over the Tempe Town Lake. The protection of the Tempe Town Lake Bridge relies on a unique combination of intrusion detection and surveillance cameras in a high-traffic area. The system provides for protecting the bridge itself and also covers the approach to the bridge and a lead track into the rail yard.

The Town Lake and its adjacent Beach Park are local focal points for major events. The beach, originally built in 1931, was renovated in 1999 as part of the construction of the lake, which is built on inflatable rubber barriers in the riverbed to confine water within its 2-mile-long boundaries. In addition to regular recreational facilities, the beach contains an amphitheater that accommodates about 5,000 people. The beach and the lake are the sites of many annual events, including two triathlons, music festivals, the fantasy of lights July 4th fireworks show, a New Year's Eve block party, and other activities that draw large crowds to the area. There are also attractions at either end of the bridge; at one end is a busy and popular nightclub and at the other side is the

Arizona State University campus. When the alignment for the transit project was approved, the need for a bridge over the lake became a major element of the project owing to the area's popularity and because of the large amount of traffic in the area. The need for modern and dependable protection of the LRVs and of pedestrians was immediately apparent. Since its opening, the bridge has become integrated into the activities associated with the lake. Its construction began in early 2005; a lighting ceremony celebrated the completion of its most important parts 1 year later, and since the official opening of the transit system, a LED light display under the bridge casts varying colors onto the lake after dark.

The surveillance system was installed by NICE; cameras are high-resolution color analog that is converted to digital. All cameras and security systems feed into Valley Metro's fiber-optic backbone, which eliminates outside connections and makes it virtually impossible to hack the system. All cameras record continuously; images from facility cameras at the control center are stored for 30 days and onboard LRV images are stored for 3 days. Management has attempted to determine the overall costs of the system by separating the camera system from the rest of its communications equipment, but has been advised by its communication engineer that it is impossible to section out costs in this way.

The first line of security for the bridge is the responsibility of the Passenger Assistance Agents at the control center, who monitor the surveillance cameras and intrusion alarms. They dispatch security officers for all intrusions, and the Tempe Police Department typically responds. The nature of police statistics, which are based on events that occur rather than those that are prevented, makes it impossible for Valley Metro to know the number of people who have been deterred from trespassing because of the publicity about the intrusion detection warning system or the surveillance cameras. Since the opening of the transit system, though, the Tempe police have received notifications that resulted in 21 arrests and three warnings. Because DHS has identified the bridge as critical infrastructure, trespassing is considered a felony, the most serious category of crime. This is highly unusual; trespassing is generally not treated as felonious. In addition, 25 reports of activity were deemed unfounded because although police were dispatched, no trespassers or other unusual activities were observed in the area.

### **Current and Future Upgrades**

Because it was a new transit system at the time it developed its surveillance capabilities, Valley Metro was not eligible for DHS funding. It is the only agency that participated in the synthesis that reported that 100% of its funds for its surveillance system were derived from agency funds. Valley Metro is attempting to obtain outside funding through either DHS or the American Recovery and Reinvestment Act to incorporate analytics into its existing surveillance network, but thus far has not been awarded funds under either program.

### **Lessons Learned**

Engleman attributes much of the success surrounding the light rail system's entire surveillance network, but particularly the Town Lake Bridge system, to the cooperation and continuity that began with the Fire Life Safety and Security Committee and that has continued until the present time. What might seem to be a complex policing arrangement-involving three local jurisdictions and a private security firm is successful because the police departments work well together and because they became involved with transit agency system design years before the start of revenue operations. Each city had time to consider its transit security arrangements and to decide, in consultation with Valley Metro, how to provide patrol coverage as well as how to respond to emergencies on the rail system.

Valley Metro reinforces its own role in protecting its property by investing in electronically protecting the Town Lake Bridge, as well as all other facilities, and also by sharing its surveillance images with local police to help them solve incidents and investigate accidents. Valley Metro also helps keep the local police from becoming overburdened with transit-related calls by having its emergency call boxes linked to its Operations Control Center rather than directly to the police so that it can filter out calls that are not actual emergencies, such as patrons using the phone to find out when the next train is due to arrive. Although a state-of-the-art surveillance system benefits the transit system and local police, planning and continued cooperation are important elements of ensuring that maximum value is obtained from the surveillance network.

## CONCLUSIONS

This synthesis presented a current snapshot of the use of electronic video surveillance technology by passenger rail agencies. It placed that usage in a historical context and discussed new technology involving video analytics and sensors and emerging issues such as video surveillance protection of the right-of-way (ROW). It presented numerous findings, including the following:

- The overwhelming majority of passenger rail transit agencies rely on electronic video surveillance somewhere on their property.
- Despite the focus on electronic video surveillance systems in the context of terrorism since September 11, 2001, most passenger rail transit agencies have employed surveillance on their systems since the 1990s, and some as early as the 1970s.
- The largest single set of locations where electronic video surveillance cameras were used was stations, station platforms, and shelters. Unsurprisingly, systems that came into existence in the past 10 years are more likely to make greater use of video surveillance than older systems.
- More than half the respondents (28 agencies) employed video surveillance cameras in their patron parking areas.
- The same number of agencies (28, though not all the same agencies) employed surveillance cameras onboard vehicles; fewer than half of these (11) indicated its use in operator/cab areas.
- More than half the respondents relied on video surveillance in storage yards, administrative areas, or other nonpublic areas.
- Of the uses presented, right-of-way (ROW) surveillance was used least frequently and was most likely to be installed near stations.
- Light rail systems were more likely to employ onboard video surveillance than heavy or commuter rail systems; many respondents indicated that at least 75% of their vehicles had cameras. This difference can be attributed to the age of these systems. Newer systems were more likely to have had video surveillance cameras installed by the railcar manufacturer and were more likely to indicate that all new vehicles will have video systems pre-installed.
- More than half the video surveillance systems are digital rather than analog, but most are either a combination or in transition. The most common special features were 24-hour recording, existence of a secondary power source, and low-light resolution. Recent media attention to video analytics is not yet reflected widely in transit agencies' technology.
- Almost half the agencies assign personnel to monitor video cameras on a 24-hour, 7-day-a-week basis. The most common staffing configuration is a combination of police/security and rail operations personnel. Agencies that do not monitor their cameras regularly or at all indicated that personnel costs were the major determining factor.
- A majority of agencies archive video images, although the retention periods differed substantially from a few days to a year or more. Similarly, access to images is controlled by the agencies. The most common limitation is "designated individuals only," which most often includes police/security personnel, rail operations supervisors, and risk management personnel.
- The two most common applications of video surveillance were crime/vandalism prevention and accident investigation; the least common application was employee monitoring.
- Few agencies had surveyed patrons on whether the use of video surveillance added to their perceptions of security. Fewer still had measured employee perceptions or had consulted employee groups in the decision to install surveillance systems.
- Agencies provided their percentage of funding for surveillance systems from various sources; they were not asked to provide actual dollar amounts of the funds received. The largest current funding source for surveillance systems is DHS; the next largest funding source was the FTA grant program.

Several major conclusions can be drawn from these findings:

- **Reliable funding sources are necessary to assist agencies in making more effective use of available grants to upgrade security systems.** The process for obtaining funding for initial purchases or upgrading existing video surveillance systems is complex and time-consuming. Many agencies rely primarily on DHS for all or most of their funds. The funding process involves a number of agency offices—most often

police/security, safety, risk management, information technology, finance, and grant application personnel—which results in a large amount of employee collaboration. However, because funds must be applied for on a yearly basis, it is difficult to anticipate the success of and even more difficult to plan for multiyear projects. Presently, DHS is seen as the largest single source of funding for security training and equipment purchases, and as a result it has a large influence on decisions made by transit agencies regardless of size, location, or mode.

- **Agencies are seeking forums to share ideas and best practices.** Despite large expenditures for design and purchase of surveillance equipment, transit agencies are highly dependent on vendor claims and on procedures that may require selection of the lowest bidder. Agencies would benefit from a forum to share transit-specific requirements and experiences to balance against unsubstantiated claims. This role could be filled by the U.S.DOT or by one or more transit-specific professional associations.
- **Policies on image access and retention are inconsistent.** Transit agencies follow a variety of procedures in these areas. Some are guided by state laws pertaining to records maintenance and access but there is little overall guidance in establishing access and retention policies. The forum described previously could provide guidance and uniformity in these areas. Transit police/security managers might also consult with local police in their jurisdictions for additional information because having similar policies may be useful if local prosecutors or civic groups question their existing procedures.
- **ROW surveillance is an emerging issue.** Relatively few agencies provide any surveillance of their ROWs; those that do provide it primarily immediately adjacent to stations. Though the reasons for this appear to be primarily cost-related, there are also issues pertaining to ownership of the ROW and adjacent areas; how and by whom surveillance equipment would be installed, monitored, and archived; and a number of other unanswered questions.
- **Publicizing successful applications of video surveillance may result in diversifying funding sources for system installation and upgrading.** Because crime/vandalism prevention remains the single largest use of video surveillance by transit systems, agencies might work more closely with local media when malefactors are observed and caught in the act of committing a crime or when video images play a role in post-event investigation of a crime. Publicity given to these types of events may assist agencies in obtaining local funding for installation and upgrading of video systems, resulting in less reliance on the competitive grant structure developed by DHS. However, media attention may result in criticism by groups opposed to the expansion of surveillance systems in public spaces.

Although many conclusions are possible based on the analysis of the questionnaire data, the literature review, and other research sources, a number of important areas that require additional study have been developed. This section briefly expands on the areas for future study enumerated in the summary.

- *Measuring the value of surveillance systems in enhancing patrons' perceptions of security in transit stations, platforms, or shelters and onboard railcars.* The major application of video surveillance systems is for crime/vandalism prevention, but few agencies have surveyed patrons on whether the systems add to their feelings of security. Studies could gauge patron awareness of the use of surveillance, whether it adds to their feelings of security, and whether it influences their decisions on whether to ride mass transit. Related to this are questions of whether patrons should always be informed that such systems are in use, how they would be informed of this, specific wording that meets any existing local or state legislative mandates and legal requirements, and the best methods for creating such awareness (i.e., public address announcements, signage, seat notices, and/or local media coverage). An indirect benefit of such studies might be to establish a cost/benefit methodology for determining either the intrinsic or psychological value of whether installing surveillance systems directly or indirectly affects patronage, particularly ridership.
- *Measuring employee responses to surveillance systems.* This synthesis found that few transit agencies have included employee representatives in decisions involving surveillance applications or in their perceptions of whether such systems are to their benefit or exist primarily to oversee and report on their activities. Further study could help to determine how employees perceive surveillance systems in their work locations and, if their perceptions are that surveillance enhances their safety and security, whether they might be encouraged to become involved as advocates for surveillance system expenditures. By contrast, if employees are found to perceive surveillance systems negatively (e.g., existing primarily to enhance disciplinary proceedings), joint labor/management committees might be formed to create a more positive image of the value of video surveillance as a workplace safety and security feature.
- *Policy development in the area of image access and retention, and on legal issues surrounding public access to images.* One of the largest variations in replies to survey questions was in the areas of image access and retention. Retention ranged for virtually none at all unless something exceptional was observed to more than a year, including up to 3 years in one agency. Similarly, although most agencies indicated that only “designated individuals” could access images, the list of such individuals was broad. Of the

41 agencies that answered the specific question on public access policies, 17 indicated they had none. Many civil liberties groups have filed or indicate that they are planning to file lawsuits on the proliferation of surveillance systems in public areas. A review of existing laws, court decisions and pending litigation, and any existing model policies in these areas would provide much-needed guidance to transit agencies and could preclude costly and time-consuming litigation.

- *Establishing forums to share best practices and assess equipment performance.* This synthesis found what appear to be insufficient opportunities to share best practices. Two-pronged research is suggested. An initial study might consider what departments or officers within an agency are internal stakeholders in the purchase or expansion of surveillance systems and delve into how participants decide from whom to seek funding. Among those that might be surveyed are police/security, safety and risk management, rail operations, information technology, purchasing, and service and maintenance. With this information, further study could develop recommendations for an appropriate forum or forums for stakeholders to share information on best practices to assess the performance of particular equipment in the transit environment.
- *Leveraging internal stakeholder input.* Each case study agency reinforced that obtaining funding for surveillance installation and upgrading required an agency-wide effort. Internal stakeholders include police/security, safety, risk managers, information technology, and budgetary personnel, as well as those who regularly apply to external funding sources. Many of these individuals meet regularly through existing security and safety committees. Questionnaire responses indicated that employee organizations are infrequently involved in surveillance utilization decision. Studies focusing on the interrelationships of these groups might bring about more nuanced decisions on how and where to deploy surveillance technology.
- *Leveraging external stakeholder input.* External stakeholders may influence a transit agency's decision to install or expand its use of video surveillance. No research could be located on how community crime prevention groups, including women's safety advocacy groups, might assist in obtaining funds or making decisions whether and where to install electronic surveillance systems. Existing research confirms that women are more likely to indicate fear of victimization and that public transit locations rank high on areas they find threatening. Transit agencies might consider partnering with women's groups to publicize their crime-prevention efforts through events that could enhance their participation in the local community and lead to ridership increases.
- *Technical studies of surveillance technology.* Transit agency environments differ from office buildings or

retail establishments. Weather conditions, varying hours of operation, absence of climate control, lighting levels, and the like add to the technical complexities of selecting and maintaining a surveillance system. A series of studies focused more specifically on systems' needs and vendors' claims could minimize expenditures and maximize value. Because of the large number of transit agency offices involved in surveillance technology decisions, there is a need to look beyond the decision itself by also considering how the agency will define concepts of value and performance, what expertise exists within the agency to validate vendor claims, and what ancillary benefits are sought (e.g., will the surveillance system be part of an automatic train control system, is it viewed primarily as a security feature or in terms of fare collection or parking fee collection control, or as part of a more general safety-related risk mitigation system). Answers to these questions are likely to influence the type of technology being considered and to help determine what constitutes "value"—a term that has different meanings to different rail agency officials. Some officials may think in financial terms and others may think in terms of less well-defined areas such as patron perception, terrorism or crime prevention, or mitigation against litigation.

- *Studies specifically on the emerging issues in ROW surveillance.* Although relatively few agencies provide ROW surveillance, system liability concerns—particularly in crossing-gate areas or accidents involving light rail vehicles and road vehicles, and the possibility of terrorist-inspired vandalism to tracks—make protecting ROWs an issue to be studied separately from surveillance use in patron and employee areas. There are indications that ROW surveillance will become an issue of increasing focus by transit agencies and by the federal government, including decisions on installing video surveillance along key portions of systems' ROWs. Studies into the costs and related issues involved in protecting ROWs could be undertaken now, before opinions are set based on assumptions rather than on reviews of the legal issues or existing case studies.
- *Studies focusing on the emerging issue of operator/cab surveillance.* The Metrolink directive and subsequent litigation indicate that video surveillance in operator/cab areas will remain controversial for some time to come. Transit agencies should consider looking into the costs of implementation and labor/management issues, rather than awaiting federal rule-making in this area.
- *Possibilities for partnering with other transit agencies or railroads.* A number of transit agencies have overlapping jurisdictions with other transit agencies, sharing either stations or ROWs. Studies could determine whether agencies might share the costs and responsibilities of installation and maintenance of video surveillance systems, particularly where public transit agencies share track with privately owned freight

railroads. Research might assist in developing plans for surveillance systems along ROWs that currently depend solely on relatively uncoordinated patrols by law enforcement or security personnel from a number of different jurisdictions. Partnering among transit agencies or with private railroads may also expand funding sources beyond the current dependence on DHS and, to a lesser degree, FTA.

- *Possibilities for partnering with local government.* A number of transit agencies, including case study agencies, are located in cities that are vastly increasing their video surveillance networks. Studies of regional traffic management plans might assist the transit agencies whose jurisdiction may go beyond the boundaries of a particular municipality to be considered in such plans for surveillance systems, particularly where light rail

vehicles share roadway with other vehicles or where grade crossings play a role in overall traffic planning and risk mitigation. Such research might help transit agencies obtain funds as part of municipal planning rather than having to act separately from other government entities. It might assist the agencies in participating more fully in larger traffic management studies and related funding requests. As with partnering with private railroads, partnering with local government may expand the funding sources on which rail transit agencies have come to depend.

These and similar studies would help transit agency managers make better use of their existing resources and find imaginative solutions to more efficiently use video surveillance technology.

## ABBREVIATIONS AND ACRONYMS

ACE	Altamont Commuter Express (California)	Muni	San Francisco Municipal Transportation Agency
BART	Bay Area Rapid Transit District (California)	NFTA	Niagara Frontier Transportation Authority (New York State)
BNSF	Burlington Northern Santa Fe Railway	NJT	New Jersey Transit
CCTV	closed-circuit television	NYCT	New York City Transit
CPTED	crime prevention through environmental design	PAAC	Port Authority of Allegheny County (Pennsylvania)
CTA	Chicago Transit Authority (Illinois)	PANY&NJ	Port Authority of New York and New Jersey
FBI	Federal Bureau of Investigation	PATCO	Port Authority Transit Company (New Jersey)
GAO	United States Government Accountability Office	PATH	Port Authority Trans Hudson (New Jersey and New York State)
GCRTA	Greater Cleveland Regional Transit Authority (Ohio)	PPD	Phoenix Police Department
GPS	global positioning system	RAPT	Régie Autonome des Transports Parisiens (France)
IT	information technology	ROW	right-of-way
LACMTA	Los Angeles County Metropolitan Transportation Authority (California)	RFP	Request for Proposal
LIRR	Long Island Rail Road (New York State)	RTD	Regional Transportation District, Denver (Colorado)
LRV	light rail vehicle	SCADA	Supervisory Control and Data Acquisition System
LU	London Underground (United Kingdom)	SCP	situational crime prevention
MARTA	Metropolitan Atlanta Rapid Transit Authority (Georgia)	SEPTA	Southeastern Pennsylvania Transportation Authority
MBTA	Massachusetts Bay Transportation Authority	SRTD	Sacramento Regional Transit District (California)
METRAC	Metro Action Committee on Public Violence Against Women and Children	TransLink	Greater Vancouver Transportation Authority
METRO	Metropolitan Transit Authority of Harris County (Texas)	Tri-Met	Tri-County Metropolitan Transit District (Oregon)
METRO	Valley Metro Rail (Arizona)	TSGP	Transit Security Grant Program
Metrolink	Southern California Regional Rail Authority	TTC	Toronto Transit Commission (Canada)
MetroLink	Bi-State Development Agency (Missouri)	TVM	ticket vending machine
MetroRail	Miami-Dade Transit Metrorail (Florida)	UPRR	Union Pacific Railroad
MTA-MD	Maryland Transit Administration (Maryland and Washington, DC)	WMATA	Washington Metropolitan Area Transit Authority (Maryland, Virginia, and Washington, DC)
MTA	Metropolitan Transportation Authority (New York State and Connecticut)		
MTI	Norman Y. Mineta International Institute for Surface Transportation Policy Studies Institute (San Jose, California)		
MTR	Mass Transit Railway (Hong Kong)		

## GLOSSARY

**Alignment**—the pathway on which the train travels; in the light rail transit industry, alignment is also frequently referred to as the guideway or the fixed guideway; in the heavy, commuter, and freight rail industry, this is most often referred to as the right-of-way.

**Analog surveillance system**—analog cameras convert information to an analog signal that may be displayed in real time on a monitor, recorded onto a videotape storage device, or both; the first generation of surveillance systems were all analog, but as transit agencies upgrade their systems most are turning to digital technology.

**At-grade**—tracks are at-grade when they are on the same level as the roadway or the existing rail tracks that they parallel; grade-separated tracks are those above or below the existing roadway or tracks.

**Commuter rail**—FRA-compliant railcars powered by either diesel or electricity that provide regional passenger service or service between a central city and its suburbs. Commuter rail service is provided on regular railroads or former railroad rights-of-way; trains may be self-propelled or hauled by locomotives. Commuter rail is characterized by high-speed, infrequent-stop service. Examples: Virginia Railway Express (VRE), the Metropolitan Transportation Administration's Long Island Railroad (LIRR) and Metro-North Railroad (MNRR), New Jersey Transit (NJT), and Northstar Commuter Rail (Minneapolis, MN).

**Consist (pronounced CON-sist)**—a group of railcars combined to make up a train; four rail cars running as one train is called a four-car consist.

**Covert surveillance**—cameras are hidden and there is no signage indicating their installation; this approach is best suited to crime detection and in a transit environment would most likely be installed where a problem with crime or fraud has been established and the agency's aim is to make apprehensions to pursue criminal or civil actions.

**Digital surveillance system**—digital cameras convert image information into data that can be displayed, stored, or both; because storage is on a compact disk or a computer's hard drive, it is less space-intensive than an analog system; additionally, because exact copies of the images can be made, they are considered more accurate and more dependable than analog systems as evidence for cases involving retroactive investigation.

**Heavy rail**—electric railways characterized by high speed and rapid acceleration; passenger railcars that operate on rights-of-way separate from other vehicular and/or pedestrian traffic; trains are boarded in stations from high-level platforms. The service may be referred to as a subway although stations and parts of the right-of-way

may be at or above ground level. Examples: Metropolitan Atlanta Rapid Transit Authority (MARTA), Washington Metropolitan Area Transit Authority (WMATA), and the Metropolitan Transportation Authority's New York City Transit (NYCT).

**Injury**—harm to a person resulting from a single event, activity, occurrence, or exposure of short duration.

**Light rail**—features lightweight passenger rail vehicles that operate singly or in two- or four-car trains on fixed rails on alignments that often share streets and roadways with other traffic. Light rail systems are generally powered by an overhead electric line; passengers board in stations or from track-side stops in the street. Streetcars are a type of light rail service with frequent stops and nearly the entire route is operated in streets to allow passengers to board and alight quickly. Examples: Denver's Regional Transportation District (RTD), Utah Transit Agency, and Phoenix's Valley Metro Rail.

**Overt surveillance**—cameras are in view of the public and their existence is generally accompanied by signage alerting people that they are in an area that is under video surveillance. There is a strong crime prevention element to such systems, but, depending on how accessible and visible the cameras are to the public, there is a possibility of tampering with and vandalizing the equipment.

**Pan-tilt-zoom camera**—a camera that can pan (move left and right), tilt (move up and down), and zoom in or out; its dome can rotate 360 degrees to view an object directly below it. Pan-tilt-zoom cameras are preferred because of their greater viewing range and because the camera can be remotely controlled by viewers to look more closely at specific events that have attracted their attention or to which they have been alerted by analytics.

**Right-of-way (ROW)**—the pathway on which the train travels; any piece of equipment/person within 25 feet of the track is considered to be in the ROW. [See also Alignment]

**Semi-covert surveillance**—cameras are in public view but concealed, often behind one-way transparent cases; this approach is similar in its crime prevention efforts to an overt system but provides greater protection to the equipment and makes it more difficult for the public to know the number of cameras or their exact locations.

**Transit system**—the facilities, equipment, personnel, and procedures needed to provide and maintain public transit service.

**Trespassers**—persons on a railroad's property in railroad operation whose presence is prohibited or unlawful; a

person on a highway-rail crossing is not classified as a trespasser unless the crossing is protected by gates or barriers that were closed when the person entered the crossing, or unless the person attempted to pass over, under, or between cars or locomotives of a train occupying the crossing. Non-trespassers on railroad property are persons lawfully on property used in railroad operation (other than employees, passengers, trespassers, or

contractors), and persons adjacent to railroad premises when they are injured owing to railroad operations. Off railroad property they are persons affected by an event which begins on railroad property but ends on non-railroad property, for example, a derailment that results in a release of hazardous materials onto non-railroad property, which injures a “nontrespasser” located on that property.

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## LITERATURE REVIEW [ANNOTATED BIBLIOGRAPHY]

Balog, J.N., A.N. Schwartz, and B.C. Doyle, *Transit Security Procedures Guide*, Federal Transit Administration, U.S. Department of Transportation, Washington, D.C., 1994.

This FTA guide provides a systems approach to transit security planning and implementation, provides procedures for immediate and follow-up responses to incidents, and highlights a number of common transit security problems as well as defensive actions systems can employ to minimize those problems.

Balog, J.N., A.N. Schwartz, and B.C. Doyle, *Transit System Security Program Planning Guide*, Federal Transit Administration, U.S. Department of Transportation, Washington, D.C., 1994.

At the time of publication, the FTA encouraged but now mandates that all transit agencies develop and implement a system security plan. Although aspects of the document are no longer policy, the guide contains a useful bibliography of about 200 items on transit security.

Barbeau, S., M. Labrador, P. Winters, and N.L. Georggi, *Enhancing Transit Safety and Security with Wireless Detection and Communication Technologies*, Final Report BD549 RPWO # 45 for the Florida Department of Transportation, Tampa, Fla., National Center for Transit Research, Center for Urban Transportation Research, University of Florida, 2008.

Report on a project to develop a scalable, real-time intrusion detection and remote notification system using wireless sensor networks; it is an alternative or supplement to traditional wired security systems for protecting such areas and facilities as garages, tunnels, and yards.

Bennett, T. and L. Gelsthorpe, Public Attitudes Towards CCTV in Public Places, *Studies on Crime Prevention*, Vol. 5, No. 1, 1996, pp. 72–90.

When asked to rank desired crime prevention strategies that included CCTV, more police officers patrolling on foot, or brighter street lights at night, CCTV ranked third.

Black, T., Cameras Make Portland Buses More Secure, *The American City & County*, Oct. 1998, p. S18.

In 1987, Portland, Oregon, Tri-Met began its use of surveillance technology by equipping three buses with three cameras each. In the mid-1990s, the agency equipped 40 buses with three cameras each. Tri-Met has been equipping buses, rail cars, and facilities with digital cameras. The digital system provides sharp, focused images; good color; and the ability to manipulate data. The cameras are easily visible, and signage alerts riders of the cameras' presence. In addition to serving as a crime deterrent and providing potential evidence in the event of criminal proceedings, cameras can prevent civil litigation or help a transit agency win a claim.

Bloom, R.F., *Closed Circuit Television in Transit Stations: Application Guidelines*, Report ED-80-1, Dunlap and Associates, Inc., Cambridge, Mass., 1980.

Provides guidelines on preventive security measures and surveillance techniques applicable for transit stations.

Chace, R.W., *An Overview of the Guidelines for Closed Circuit Television (CCTV) for Public Safety and Community Policing*, Security Industry Association, Alexandria, Va., 2001.

Developed by the International Association of Chiefs of Police (IACP) in conjunction with the Security Industry Association as part of the IACP Private Sector Liaison Committee, this primer provides guidance to law enforcement in the use of overt cameras in public areas for public safety purposes.

Clarke, R.V., Ed. *Preventing Mass Transit Crime*, Criminal Justice Press., Monsey, N.Y., 1996.

This book contains academic studies by a variety of authors who considered the use of crime prevention through environmental design and other tactics in transit environments.

Cozens, P., R. Neale, D. Hillier, and J. Whitaker, Tackling Crime and Fear of Crime While Waiting at Britain's Railway Stations, *Journal of Public Transportation*, Vol. 7, No. 3, 2004, pp. 23–41.

A study of passengers' fear at stations using Quick Time Virtual Reality, an interactive environmental stimulus for gaining insights into passengers' fear of crime. Visibility at stations was identified as a crucial factor in determining fear of crime. The design of the station's shelter is analyzed as an example of how CPTED is being implemented on railway stations by Valley Lines (Wales and Borders Trains) on its network in South Wales (UK).

DeGeneste, H.I. and J.P. Sullivan, *Policing Transportation Facilities*, Chares C. Thomas, Springfield, Ill., 1994.

Although somewhat dated, this book remains an excellent primer on the problems confronting police at airports, waterfront terminals, and rail and transit facilities. DeGeneste, the PANY&NJ retired director of public safety and superintendent of police, and Sullivan, a Los Angeles Sheriff's Department supervisory officer who has spent much of his career in transit policing, provide chapters on commuter rail and subway crime, terrorism, and problems associated with homelessness and mentally ill persons congregating in transportation facilities.

Denver RTD Embraces Camera Surveillance, *Transit Policing*, Spring 1995, p. 28.

Based on a pilot program that documented a decade of crime and vandalism on its buses, the RTD equipped its light rail vehicles with surveillance cameras.

Eder, A., After September 11, 2001: How Transit Agencies Prepare for the Threat of Terrorism, *Transportation Research Record: Journal of the Transportation Research Board*, No. 1927, Transportation Research Board of the National Academies, Washington, D.C., 2005, pp. 92–100.

This paper identifies pre-9/11 transit security planning, showing how the attacks changed the way government and transit agencies address security concerns; includes an analysis of post-1/99 security measures adopted by the FTA, New York City Transit, WMATA, and BART. A case study of Tri-Met looks particularly at the agency's responses to threats facing transit systems.

Egan, T., Police Surveillance of Streets Turn to Video Cameras and Listening Devices, *The New York Times*, Feb. 7, 1996, p. A12:1–2.

With the current focus on cameras surveilling city streets, this article is a reminder that the technology has been used in this way for more than a decade.

Fink, C.N.Y., Antiterrorism Security and Surface Transportation Systems: Review of Case Studies and Current Tactics, *Transportation Research Record: Journal of the Transportation Research Board*, No. 1822, 2003, Transportation Research Board of the National Academies, Washington, D.C., pp. 9–17.

Brief case studies of the bombing attacks in the London and Paris subway systems and the chemical gas attacks in the Tokyo subway system; recommends as cost-effective options for transit systems the use of CPTED, surveillance systems (particularly CCTV), training and exercises, and developing closer relationships with local, state, and federal agencies.

Gilbert, S., Surveillance Technologies: Electronically Leveraging Transit Security Forces, *The Police Chief*, July 1995, p. 22.

Overview of surveillance measures employed by a variety of transit agencies.

Goldgof, D.B., D. Sapper, J. Candamo, and M. Shreve, *Evaluation of Smart Video for Transit Event Detection*, Project BD549-49, Final Report, Florida Department of Transportation Research Center, Tallahassee, June 2009.

Intended to develop an evaluation framework for commercial video analytics systems, this report identifies strengths, weaknesses, areas of future research, and surveyed video analytics products. Product capabilities were identified by working with vendors and analyzing their literature. Use of analytic technology in Florida transit agencies was analyzed; a survey among the largest agencies found low use of analytics, skepticism, and poor knowledge of the technology and its capabilities. Conclusions include an evaluation framework for analytics technology, including annotation guidelines, scoring metrics, and implementation of the metrics in the scoring software.

Gordon, R., Half of Muni Surveillance Cameras Fail in Audit, *San Francisco Chronicle*, Oct. 29, 2009, n.p., accessed online.

The onboard video surveillance equipment on more than half of San Francisco Muni's buses and trains was not fully operational when the transit agency ordered an emergency audit after the stabbing of an 11-year-old boy on a city bus. The entire fleet, with the exception of cable cars and streetcars, is outfitted with cameras, but the inspection found that of the approximately 960 vehicles with surveillance devices, 22% were deemed completely nonfunctional and an additional 30% only partially functional. The audit found a range of problems, including blurry images, vandalized cameras, poor sound, broken data packs, bad cables, and inoperable recorders.

George, B. and N. Whatford, The Regulation of Transport Security Post 9/11, *Security Journal*, Vol. 20, 2007, pp. 158–170.

This paper explores regulatory initiatives that have emerged in aviation, maritime, and other forms of transport since 9/11.

Greenberger, M., The Need for Closed Circuit Television in Mass Transit Systems, *Law Enforcement Executive Forum*, Vol. 6, No. 1, 2006, pp. 151–155.

This paper advocates use of video surveillance by transit systems because they can be used anywhere, can be overt or covert, and can be monitored in real time or for later review.

Hess, D.B., Security on Buses and Trains, *Journal of Security Education*, Vol. 1, No. 4, 2006, pp. 119–132.

This paper reviews research into protecting transit facilities and recommends research on technological innovations to prevent and thwart attacks, particularly those that begin to physically and technologically “close” public transit systems and reduce unrestricted access.

*Identification of Cost-Effective Methods to Improve Security at Transit Operating/Maintenance Facilities and Passenger Stations*, FTA-FL-26-71054-03, U.S. Department of Transportation, Federal Transit Administration, Washington, D.C., July 2006.

This report reviews actions taken since the September 11, 2001 terrorist attacks by six transit agencies to increase security using cost-effective methods. It contains a summary of the consequences of terrorism on public transportation systems, and provides a literature review. Case studies/best practices include those employed at Denver's Regional Transit District (RTD), the Washington Metropolitan Area Transit Authority (WMATA), the Charlotte Area Transit System (CATS), the Massachusetts Bay Transportation Authority (MBTA), the Central Florida Regional Transportation Authority, and Bay Area Rapid Transit (BART).

Jenkins, B.M. and B.R. Butterworth, *Selective Screening of Rail Passengers*, MTI Report 06-07, Norman Y. Mineta

International Institute for Surface Transportation Policy Studies Institute, San Jose, Calif., 2007.

Focusing on terrorist risks confronting public transportation, this report explores how different forms of passenger screening, and particularly selective screening, can be implemented to reduce those risks.

Jenkins, B.M., *Protecting Surface Transportation Systems and Patrons from Terrorist Activities: Case Studies of Best Security Practices and a Chronology of Attacks*, MTI Report 97-04, Norman Y. Mineta International Institute for Surface Transportation Policy Studies Institute, San Jose, Calif., 1997.

The first phase of a study by the Mineta Institute on behalf of the U.S.DOT; this report includes case studies of transportation security in Paris, Atlanta, New York City, and by Amtrak; security surveys of nine additional U.S. cities, and an annotated bibliography of transit safety/security- and transit terrorism-related works.

Jenkins, B.M., *Protecting Public Surface Transportation Against Terrorism and Serious Crime: An Executive Overview*, MTI Report 01-014, Norman Y. Mineta International Institute for Surface Transportation Policy Studies Institute, San Jose, Calif., 2001.

This report states that for those who are attempting to kill in quantity and kill indiscriminately, surface transportation offers the ideal target; however, because of the public nature of mass transit, there is often little security with no checkpoints (unlike airports). It addresses key questions as why the level of vigilance in airports and related facilities is so different from expectations on public surface transportation systems.

Jenkins, B.M. and L. Gersten, *Protecting Public Surface Transportation Against Terrorism and Serious Crime: Continuing Research on Best Security Practices*, MTI Report 01-07, Norman Y. Mineta International Institute for Surface Transportation Policy Studies Institute, San Jose, Calif., 2001.

This report continues earlier studies by Jenkins and associates on best practices to stem terrorist assaults on surface transportation systems worldwide. This study examines security practices in effect at public surface transportation facilities in Tokyo and London—both targets of terrorist attacks—and in the San Francisco Bay Area and the Santa Clara Valley of California. It updates the chronology contained in the previous report and adds an annotated bibliography.

Leung, S.K., *A Review of Safety Strategies of Mass Transit Railway in Hong Kong*, Dissertation submitted in partial fulfillment of the requirements for Degree of Master of Arts at the University of Hong Kong, June 1999. <http://sunzi.lib.hku.hk/hkuto/view/B3195232X/ft.pdf>. Accessed Nov. 18, 2009.

This dissertation reviews safety strategies of Hong Kong's Mass Transit Railway Corporation based on patronage and coverage of the dense urban area, its comprehensive Safety Management System and the high level of safety on the system. Despite an absence of accident-based fatalities, the study concludes that if an accident were to occur in an underground section of the Mass Transit Railway, it is likely that fatalities would number in the thousands.

LaVigne, N.G., *Safe Transport: Security by Design on the Washington Metro*, in *Preventing Mass Transit Crime*, Ronald V. Clarke, Ed., Criminal Justice Press, Monsey, N.Y., 1996, pp. 163–197.

This article reviews the WMATA safety and security design features that incorporated CPTED principles and electronic video surveillance since the transit system's inception in 1976, leading many at the time to consider it the safest subway system in the world.

Longmore-Etheridge, A., *Security Works Minding the Road*, *Security Management*, Sep. 1995, pp. 24–25.

In a use of video surveillance that is today taken for granted, in 1994 an onboard bus surveillance system was instrumental in the capture and prosecution of an armed man who had hidden in the bus and forced the driver to take him to downtown Savannah, Georgia.

Loukaitou-Sideris, A., A. Bornstein, C. Fink, L. Samuels, and S. Gerami, *How of Ease Women's Fears of Transportation Environments: Case Studies and Best Practices*, MTI Report 09-01, Norman Y. Mineta International Institute for Surface Transportation Policy Studies Institute, San Jose, Calif., Oct. 2009.

This report summarizes research on women's transit fears and how safety concerns influence travel decisions. Through a literature review, focus groups, and questionnaires, it identifies women's perspectives and needs regarding transit safety; through a survey of 131 U.S. transit operators, assesses if the needs are being met and describes programs and best practices from the United States and overseas that address women's concerns. Among the findings are women passengers have distinct travel needs that not well addressed by transit agencies.

Loukaitou-Sideris, A., B.D. Taylor, and C.N.Y. Fink, *Rail Transit Security in an International Context: Lessons from Four Cities*, *Urban Affairs Review*, Vol. 41, No. 6, 2006, pp. 727–748.

This article draws from interviews with rail transit security officials, architects, and engineers responsible for designing and operating systems in London, Paris, Tokyo, and Madrid. The interviewees report on a mix of strategies to balance the trade-offs between security and openness and attractiveness of their systems, making coordination between transit agencies and police/intelligence agencies a crucial component of security planning.

Luczak, M., Smart Security Strategies, *Railway Age*, Apr., 2006, pp. 46–47.

According to LU Managing Director Tim O’Toole, you have to invest in people and rely on them; you have to invest in technology, but do not rely on it. O’Toole offered attendees of the second-annual Railway Security Forum & Expo lessons learned, emphasizing the importance of communications, not just technology. To secure LU, the agency is upgrading its 300 cameras from analog to digital and will eventually have 12,000 installed.

Mackay, D., The Changing Nature of Public-Space CCTV, *Security Journal*, Vol. 19 (2006), pp. 128–142.

Public-space CCTV has been regarded as a crime prevention tool that assists in reducing crime and has been scrutinized for its potential to infringe civil liberties. Research has concentrated on trying to fit its outputs into a matrix to make sense of the problems with recorded crime figures and overlap with other crime reduction measures, resulting in inadequate research into the activities and outputs of camera control rooms. As a result, public-space cameras systems now participate in activities than their original task of assisting the police.

Maier, P. and J. Malone, *TCRP Synthesis 38: Electronic Surveillance Technology on Transit Vehicles: A Synthesis of Transit Practices*, Transportation Research Board, National Research Council, Washington, D.C., 2001.

Based on questionnaire data, a literature review, and case studies, this report reviews existing and emerging CCTV technologies for the transit environment. Considerable technical information is presented; the descriptions of systems and terminology are particularly useful for those with little knowledge of the technical aspects and requirements of installing video systems.

Müller, C. and D. Boos, Zurich Main Railway Station: A Typology of Public CCTV Systems, *Surveillance & Society*, Vol. 2, No. 2 & 3, 2004, pp. 161–176.

This article presents a case study of the use of CCTV at the Zurich railroad station, the largest in Switzerland, as it is used by passengers, shoppers, and those defined as trespassers.

Myhre, M.L. and F. Rosso, Designing for Security in Météor: A Projected New Métro Line in Paris, in *Preventing Mass Transit Crime*, Ronald V. Clarke, Ed., Criminal Justice Press, Monsey, N.Y., 1996, pp. 199–216.

This article compares security features in the plan for Météor, the new Paris Métro line, with those of the existing system and with WMATA and the Hong Kong subway; it found that Météor included a wider range of SCP measures than existing Métros, WMATA, or Hong Kong, and that its security features were consistent with principles of CPTED.

Nakanishi, Y., *TCRP Synthesis 80: Transit Security Update: A Synthesis of Transit Practices*, Transportation Research Board of the National Academies, Washington, D.C., 2009.

An updating of the Needle and Cobb’s 1997 *Improving Transit Security* (TCRP Synthesis 21), this report covers traditional crime and terrorism, which was not included in the earlier report. Based on a survey of transit agencies, case studies, and a literature review, it updates information on security measures and practices; perception of crime, including terrorism; and counterterrorism security measures and practices, including surveillance and intrusion detection policies.

Nieto, M., K. Johnston-Dodds, and C.W. Simmons, *Public and Private Applications of Video Surveillance and Biometric Technologies*, CRB-02-006, California Research Bureau, Sacramento, 2002.

In a survey of CCTV and biometric security systems domestically and internationally, the researchers found that an increasing number of cities, schools, transit districts and public housing are deploying surveillance systems. An earlier (1997) survey found that only 13 city police departments in the country used surveillance systems, primarily to monitor pedestrian traffic in downtown and residential districts, but that since then, technological advances, declining costs, and heightened security concerns following the 9/11 attacks have led to rapid diffusion of both surveillance and biometric technologies. Also discusses applications and legal issues surrounding the technologies.

Nieto, M., *Public Video Surveillance: Is It an Effective Crime Prevention Tool?* CRB-97-005, California Research Bureau, Sacramento, June 1997.

This report examines uses of surveillance by public and private entities to prevent and discourage crime, including law enforcement practices, conditions which warrant video surveillance, legal and constitutional implications of using video surveillance, and tentative conclusions on whether the technology has benefited public housing, transit authorities, and educational institutions.

Plant, J.F. and R.R. Young, *Securing and Protecting America’s Railroad System: U.S. Railroad and Opportunities for Terrorist Threats. A Report Prepared For Citizens For Rail Safety, Inc.*, The Pennsylvania State University, Harrisburg, June 2007.

Suggests ways public policy and rail operations can be better directed to meet the challenges of terrorist activity. One of the few studies that looks at both passenger and freight rail, recommendations include congressional action to pass comprehensive rail security legislation and to establish a national commission on rail security. Other recommendations include better coordination among the many law enforcement agencies involved in rail protection, enhanced

training for railroad employees, and greater emphasis on the threats and liability issues presented by trespassers.

Platt, J.F., ed., *Handbook of Transportation Policy and Administration*, Jeremy F. Platt, Ed., CRC Press, Boca Raton, Fla., 2007.

This 32-chapter handbook covers a wide range of issues facing transit managers. Section 5 includes six chapters on security and protection of transit systems. Of these, two discuss the roles of the Department of Defense and the Department of Homeland Security in rail security, and one considers issues facing transit managers since the Madrid and London transit system terrorist bombings.

Polzin, S.E., *Security Considerations in Transportation Planning* (A White Paper for Southern Transportation Center), Center for Urban Transportation Research, University of South Florida, Tampa, no year.

This report explores the implications of enhanced security concerns on transportation planning with the expectation that security concerns will significantly influence how transportation facilities and services are provided. It is intended to foster discussion and facilitate accommodating issues such as enhanced environmental concern, social equity, evolving technologies and multimodal considerations, the inclusion of demand management strategies, and various other new goals and considerations.

Ratcliffe, J., *Problem-Oriented Guides for Police: Video Surveillance of Public Places*, Response Guides Series No. 4, Office of Community Oriented Policing Services, U.S. Department of Justice, Washington, D.C., 2006.

A primer on the use of video as a problem-oriented policing response to crime problems; most of the evaluations are from Great Britain but there is a description of cameras outside the central train station in Oslo, Norway, to combat drug activity.

Redmon, J., Atlanta Seeks to Add 500 Surveillance Cameras, *The Atlanta-Journal Constitution*, Oct. 24, 2009, n.p., accessed online.

City officials were seeking \$13.7 million in federal funds for cameras after a series of high-profile crimes; not transit-specific but addresses issues that are relevant to transit systems.

Roman, A., Securing Rail Systems from the Ground Up, *Metro Magazine*, Apr. 2009, pp. 40–43.

This article provides a brief review of how Austin's Capital Metro and Phoenix-based Valley Metro were able to integrate CPTED and surveillance into their systems beginning with their initial design phases.

Sahm, C., *Hard Won Lessons: Transit Security*. New York: Safe Cities Project, The Manhattan Institute for Policy

Research in conjunction with the Police Institute-Rutgers, Newark, N.J., 2006.

Based on conference presentations in 2005 that brought together law enforcement officials to share best practices on transit security, this collection includes material from presenters Sir Ian Johnston, Chief Constable of the British Transport Police; Jeroen Weimar, Director of Policing and Enforcement for the London Transport System; and officials from NJT Police, Amtrak, the PANY&NJ, and DHS.

Sanderson, C., A. Bigdeli, T.S., S. Chen, E. Berglund, and B.C. Lovell, Intelligent CCTV for Mass Transport Security: Challenges and Opportunities for Video and Face Processing, *Electronic Letters on Computer Vision and Image Analysis*, Vol. 6, No. 3, 2007, pp. 30–41.

As a result of the number of cameras installed, many sites have abandoned human monitoring and only record for investigations. A sought-after capability is “face in the crowd” recognition in public spaces, including transit centers. This paper evaluates approaches to face recognition, proposes adaptations and modifications, and discusses legal challenges surrounding its implementation.

Schulz, D.M. and S. Gilbert, Developing Strategies to Fight Crime and Fear, *The Police Chief*, July 1995, pp. 20–27.

Based on a TRB study into deployment of uniformed and plainclothes officers on transit properties, this article provides an overview of policing techniques and strategies employed by a number of large and small transit agencies.

Scott, D., Policing Regional Mass Transit: The SEPTA System, *FBI Law Enforcement Bulletin*, Vol. 78, No. 7, July 2009, 10 pp., accessed online.

This case study, written for law enforcement professionals, outlines the steps taken by SEPTA to establish policies to maximum safety and security of its passengers, employees, and the public and to protect the transit agency from loss or damage.

Smith, M.J., Addressing the Security Needs of Women Passengers on Public Transport, *Security Journal*, Vol. 21, 2008, pp.117–133.

This article presents a framework for analyzing security needs of women passengers, summarizing research in four areas: (1) women's reported victimization, (2) calculating the risk of being a crime victim, (3) the rationality of women's fears of crime and disorder, and (4) the need for crime prevention measures to address these security-related issues. The “whole journey” approach highlights aspects of the trip for women that require special attention.

*Track and Tunnel Intrusion Detection: White Paper*, Vidient Systems, Inc., Santa Clara, Calif., 2009.

Report on the technological capabilities required to provide track and tunnel intrusion detection, including immediate notification and assessment and full-time protection.

Zurawski, N. and S. Czerwinski, Crime, Maps and Meaning: Views from a Survey on Safety and CCTV in Germany, *Surveillance & Society*, Vol. 5, No. 1, 2008, pp. 51–72.

After examining what people knew about video technology and what meaning they ascribed to it, this article found

that perception of “dangerous spaces” has resulted in CCTV being seen as suitable for safeguarding crime hot spots. Although the authors reject the expansion of CCTV, they view it as a way to counter crime in particular settings.

## APPENDIX A

### Synthesis Questionnaire

#### Rail Security: Right-of Way Surveillance and Vehicle Security Cameras A Transportation Research Board Synthesis Study

**Project purpose:** This TCRP synthesis project (J-7/SA-24) is studying the use of surveillance systems in rail transit, including how and where surveillance is used, the types of equipment used, who monitors the video, policies on access to the images and chain of custody, and use of the images for criminal, civil, or agency disciplinary prosecutions. Questions ask you to evaluate the value of surveillance in a variety of situations and from where funds for your system were obtained.

The questions address many issues; given the wide variety of circumstances and systems, not all questions may be appropriate for all agencies. If a question is not relevant to your system, leave it blank. If you have questions, please contact the principal investigator, Dr. Dorothy M. Schulz at [dms10024@aol.com](mailto:dms10024@aol.com) or at [dms@ieitransit.com](mailto:dms@ieitransit.com). Answers are confidential to the extent that information will not be linked to your agency without your approval or unless you have been selected as a case study agency. But please identify yourself and your agency so that in our report we are able generalize about agencies based on size, mode, geography, or other group factors.

The case studies will focus on agencies whose use of surveillance will be particularly helpful to general managers, police/security chiefs, and safety managers to learn how they can put technology to best use. If your agency is using surveillance in innovative ways that would benefit others, please volunteer as a case study agency. Despite most police/security and safety personnel being reluctant to volunteer, your participation will permit you to share best practices with peers, including successes but possibly things that did not work as anticipated and that others can learn from.

The final report, to be published by the Transportation Research Board, will be a user-friendly document that will assist all rail transit agencies. Your answers will help others make important decisions; their answers may be equally helpful to you as you consider the costs and labor involved in implementing or upgrading surveillance technology to advance the security and safety of your system by improving your incident management and response capabilities.

Thank you for participating.

**INSTRUCTIONS:** For multiple choice questions, please check all that apply; fill in answers may be typed directly onto the question by downloading the document onto your computer. When you have completed it, save it as a new file and follow the instructions for returning it that appear on the last page. If you are uncomfortable working directly on the computer, download and print the survey, fill it out, and follow the instructions on the last page for returning it via FAX or regular mail.

#### RESPONDENT INFORMATION:

Your name and title: (*just type even though there are no lines*) \_\_\_\_\_

Your phone number (*remember to include area code*): \_\_\_\_\_

Your e-mail address: \_\_\_\_\_

Full name of your agency: \_\_\_\_\_

**A. SURVEILLANCE SYSTEM INFORMATION**

1. Does your agency use a video surveillance system?
  - a. yes
  - b. no [If no, please go to the last page and answer two questions in Section F]
2. To the best of your knowledge, when did your system introduce video surveillance? [Please specify a year]
 

\_\_\_\_\_
3. Where does your agency use surveillance? [Check all that apply; here and for all replies, no mark indicates the choice does not apply to your system]
  - a. on board vehicles [if yes, please answer b and c]
  - b. in passenger areas
  - c. in operator/cab area
  - d. stations, station platforms, shelters
  - e. elevators only (whether ADA or all)
  - f. parking facilities
  - g. along the right-of-way (ROW)
  - h. in storage or other yards
  - i. in employee/administrative areas
  - j. other (please specify): \_\_\_\_\_
4. If on board vehicles, what percentage of your heavy rail vehicles has surveillance devices?
  - a. less than 25%
  - b. 25–50%
  - c. 51–75%
  - d. 76–100%
  - e. system has no heavy rail vehicles
5. If on board vehicles, what percentage of your com-muter rail vehicles has surveillance devices?
  - a. less than 25%
  - b. 25–50%
  - c. 51–75%
  - d. 76–100%
  - e. system has no commuter rail vehicles
6. If on board vehicles what percentage of your light rail vehicles/trolleys has surveillance devices?
  - a. less than 25%
  - b. 25–50%
  - c. 51–75%
  - d. 76–100%
  - e. system has no light rail vehicles/trolleys
7. If less than 75 percent, rank in order of importance the factors that influenced the choice of those equipped. (1 is least effective, 5 is most effect, NA indicates played no role) [place the number after the colon]
  - a. high disorder or crime rate: \_\_\_\_\_
  - b. local demands/politics: \_\_\_\_\_
  - c. enhance perceived customer safety: \_\_\_\_\_
  - d. funds available to retrofitting existing vehicles: \_\_\_\_\_
  - e. new vehicles equipped at purchase: \_\_\_\_\_
  - f. other (please specify): \_\_\_\_\_
8. What percentage of your stations, station platforms, or shelters has surveillance devices?
  - a. less than 25%
  - b. 25–50%
  - c. 51–75%
  - d. 76–100%
9. If less than 75 percent, rank in order of importance the factors that influenced the choice of those equipped (1 is least effective, 5 is most effect, NA indicates played no role) [place the number after the colon]
  - a. high disorder or crime rate: \_\_\_\_\_
  - b. local demands/politics: \_\_\_\_\_
  - c. enhance perceived customer safety: \_\_\_\_\_
  - d. funding available to retrofit existing stations, platforms, shelters: \_\_\_\_\_
  - e. new stations, platforms, shelters designed to accommodate surveillance devices: \_\_\_\_\_
  - f. other (please specify): \_\_\_\_\_
10. Indicate the types of employee facilities with video surveillance (i.e., yards, counting room, central control room, agency's headquarters):
 

\_\_\_\_\_

11. Indicate whether you use video surveillance along your right-of-way (ROW):
- a. yes
- b. no
12. If yes, where along the ROW do you use video surveillance: [*Check all that apply*]
- a. near stations
- b. at grade crossings
- c. at interchanges w/other rail systems
- d. in high disorder or crime areas
- e. other (*please specify*): \_\_\_\_\_
13. Is your surveillance system: [*Check all that apply*]
- a. analog
- b. digital
- c. combined/in transition
- d. uncertain
14. Which options does your surveillance system contain or utilize: [*Check all that apply*]
- a. 24-hour recording
- b. automatic emergency digital transmission
- c. secondary power source
- d. auto-start [records only when there is motion]
- e. low light resolution
- f. uncertain
- g. other (*please specify*): \_\_\_\_\_
17. If those viewing the cameras are police/security department personnel, are they:
- a. individuals with full police authority
- b. transit-system security officers
- c. contract agency security officers
- d. combined (*please explain*): \_\_\_\_\_
- e. other (*please explain*): \_\_\_\_\_
18. If your system is not viewed, what is the reason?
- a. administrative decision based on costs
- b. administration decision based on other considerations (*please explain*): \_\_\_\_\_
19. Does your agency archive images?
- a. yes
- b. no
20. If yes, for how long are the images retained?
- \_\_\_\_\_
21. Who may access the images? [*Please list categories of authorized persons*]
- \_\_\_\_\_
22. What procedures are used to maintain/record chain of custody of images: [*check all that apply*]
- a. sign in/sign out
- b. only designated individuals
- c. only with another authorized person
- d. other (*please specify*): \_\_\_\_\_

## B. MONITORING, RECORDING AND ARCHIVING POLICIES AND PROCEDURES

15. Are personnel assigned to view surveillance cameras:
- a. 24 hours a day, 7 days a week
- b. during hours of service only
- c. none assigned (*go to Question 18*)
- d. another configuration (*please explain*): \_\_\_\_\_
16. If the system is viewed during any hours of operation, are those who view the cameras:
- a. police/security department personnel
- b. rail operations personnel
- c. combined

## C. SURVEILLANCE APPLICATIONS

23. For what purposes does your agency use surveillance? [*Check all that apply*]
- a. crime/vandalism prevention
- b. fare collection review/dispute mediation
- c. other complaint resolution
- d. accident investigation
- e. employee monitoring
- f. other (*please explain*): \_\_\_\_\_

Questions 24 to 29: On a five-point scale rate how effective you feel surveillance has been for each. (*1 is least effective, 5 is most effect, NA indicates video not used for this*) [place the number after the colon]

24. For crime/vandalism prevention:  
\_\_\_\_\_
25. For fare collection review/dispute mediation:  
\_\_\_\_\_
26. For other complaint resolution:  
\_\_\_\_\_
27. For accident investigation:  
\_\_\_\_\_
28. For employee monitoring:  
\_\_\_\_\_
29. For other (*if more than one, specify uses*):  
\_\_\_\_\_
30. Have you used surveys or other ways to measure patron perceptions of security since the surveillance system was installed?  
 a. yes  
 b. no
31. If yes, do patrons report a higher sense of security?  
 a. yes  
 b. no
32. Have you used surveys or other ways to measure employee perceptions of security since the surveillance system was installed?  
 a. yes  
 b. no
33. If yes, do employees report a higher sense of security?  
 a. yes  
 b. no
34. Have you been able to demonstrate a reduction in fraudulent injury or other claims based on your surveillance system?  
 a. yes  
 b. no

35. Have you or local police agencies used your surveillance images for criminal prosecutions:  
 a. yes  
 b. no
36. Have you used evidence from the system in civil cases or employee disciplinary actions?  
 a. yes  
 b. no

#### D. LEGAL AND PRIVACY ISSUES

37. Does your agency notify patrons that surveillance cameras are in use?  
 a. yes  
 b. no
38. Were unions/employee representatives consulted in the decision to install surveillance technology?  
 a. yes  
 b. no
39. Has your agency established policies for public access to surveillance images/records?  
 a. yes  
 b. no

#### E. FUNDING AND PLANNING

40. Thinking how your agency paid for its surveillance system, indicate the percentage of funds from each source: (*do not indicate actual dollar amounts*) [place the number after the colon]
- a. from FTA grant program: \_\_\_\_\_ %
- b. from Homeland Security (DHS): \_\_\_\_\_ %
- c. from state grants: \_\_\_\_\_ %
- d. from municipal grants: \_\_\_\_\_ %
- e. from agency funding: \_\_\_\_\_ %
- f. from vendor funding or grant: \_\_\_\_\_ %
- g. from other (*please explain*): \_\_\_\_\_ %
- \_\_\_\_\_

41. Do plans call for all new vehicles to be equipped with surveillance cameras when placed into revenue service?
- a. yes
- b. no
42. If the answer to 41 is yes, will be cameras be placed in:
- a. patron areas only
- b. patron areas and operator/cab areas
43. Are surveillance cameras included in all new station design plans?
- a. yes
- b. no
44. If you know, specify the manufacturer of your equipment. *[If more than one, please list in order of the oldest equipment first, the newest last.]*
- 

**F. SYSTEMS WITHOUT SURVEILLANCE TECHNOLOGY**  
***[If Your System Does Not Use Surveillance Technology Please Complete This Section.]***

45. If your agency is considering installing a surveillance system, where? *[Check all that apply]*
- a. stations, platforms, shelters
- b. vehicles
- c. both
- d. employee/administrative areas
- e. along the ROW
- f. not considering it

46. If your agency is not considering installing a surveillance system, why not? *[Check all that apply]*
- a. too expensive
- b. not necessary
- c. legal concerns
- d. other *(please explain)*: \_\_\_\_\_

MAY WE CONTACT YOU FOR FUTHER INFORMATION?

- Yes
- No

THANK YOU FOR PARTICIPATING.

Instructions for returning your questionnaire:

Via E-Mail: Rename the file using “save as” (please add your agency’s name to the file) and e-mail to Dorothy Schulz at dms10024@aol.com or dms@ieitransit.com

Via Fax: Address your cover sheet to Dorothy Schulz or Susan Gilbert at 1-212-490-9611

Via Mail: Send to:

Dorothy M. Schulz, Ph.D.  
 Director of Transit Security  
 Interactive Elements Incorporated  
 60 East 42nd Street, Suite 2035  
 New York, New York 10165

IF YOU HAVE QUESTIONS: E-mail Dr. Schulz

## APPENDIX B

### Questionnaire Respondents

Altamont Commuter Express (ACE), Stockton, CA

Amtrak, Washington, DC

Bay Area Rapid Transit District (BART), San Francisco, CA

Cambria County Transit Authority (Camtran), Johnston, PA

Central Arkansas Regional Transit Authority (CATA), North Little Rock, AR

Charlotte Area Transit System (CATS), Charlotte, NC

Chattanooga Area Regional Transportation Authority (ARTA), Chattanooga, TN

Chicago Transit Authority (CTA), Chicago, IL

Connecticut Department of Transportation (CDOT), New Haven, CT

Delaware River Port Authority (DRPA), Camden, New Jersey

Detroit Transportation Corp. (The People Mover), Detroit, MI

Greater Cleveland Regional Transit Authority (GRCTA), Cleveland, OH

Hampton Road Transit Light Rail (The Tide), Hampton, VA

Jacksonville Transportation Authority (JTA), Jacksonville, FL

Los Angeles County Metropolitan Transportation Authority (LACMTA), Los Angeles, CA

Massachusetts Bay Transportation Authority (MBTA), Boston, MA

Memphis Area Transit Authority (MATA), Memphis, TN

Metra, Chicago, IL

Metropolitan Transit Authority of Harris County (METRO), Houston, TX

Metro Transit, Minneapolis, MN

Metropolitan Atlanta Rapid Transit Authority (MARTA), Atlanta, GA

Miami-Dade Transit, Miami, FL

Nashville Metro Transit Authority [Music City Star] (RTA), Nashville, TN

New Jersey Transit (NTJ), Newark, NJ [includes Hudson-Bergen Light Rail]

New Orleans Regional Transit Authority (NORTA), New Orleans, LA

Niagara Frontier Transportation Authority (NFTA), Buffalo, NY

Northern Indiana Commuter Transportation District, East Chicago, IN

Orange County Transportation Authority (OCTA), Orange, CA

Port Authority of Allegheny County (PAAC), Pittsburgh, PA

Port Authority of New York and New Jersey (PANY&NJ), Jersey City, NJ

Rail Runner Express, Albuquerque, NM

Regional Transportation District (RTD), Denver, CO

Rock Island County Metropolitan Mass Transit District (MetroLink), Moline, IL

Sacramento Regional Transit District (SRTD), Sacramento, CA

San Diego Metropolitan Transit System (The Trolley), San Diego, CA

San Francisco Municipal Transportation Agency (Muni), San Francisco, CA

Southern California Regional Rail Authority (SCRRA), Pomona, CA

Sound Transit, Seattle, WA

South Florida Regional Transportation Authority [Tri-Rail] (SFRTA), Pompano Beach, FL

Tri-County Metropolitan Transportation District of Oregon (Tri-Met) [Metropolitan Area Express—MAX], Portland, OR

Utah Transit Authority (UTA), Salt Lake City, UT

Valley Metro Rail, Phoenix, AZ

Washington Metropolitan Area Transit Authority (WMATA), Washington, DC

*Abbreviations and acronyms used without definitions in TRB publications:*

AAAAE	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	Air Transport Association
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
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
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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Washington, D.C. 20001

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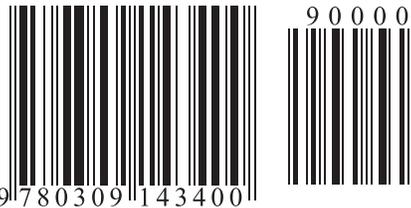
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