



Digital Video Surveillance:

*enhancing physical security with
analytic capabilities*

*Stephen Russo
Director of Security and Privacy Technology
IBM Corporation*

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Executive Summary

Over the past several decades, surveillance techniques have matured dramatically. Analog tapes and security personnel are being replaced with Internet Protocol (IP) technology, leveraging digital video cameras, remote access, and intelligent analytics. This evolution provides organizations with significant opportunities to improve security and reduce operating costs.

Today's businesses and public agencies are faced with a critical need to protect employees, clients, citizens and assets from possible threats with a security system that enables rapid response to security breaches and prompt investigation of events. Organizations are additionally challenged with managing tremendous amounts of information in various forms, including video, voice, electronic data and paper.

IBM, along with industry-leading Business Partners, can help organizations meet these challenges and enhance their physical security capabilities with innovative, integrated digital video surveillance solutions. IBM can help design and implement a plan that enables organizations to assess, detect, protect and recover from security exposures in their information technology (IT) and physical security environments.

One of the key aspects of this plan is IBM Smart Surveillance Solution (SSS), an end-to-end, intelligent digital video surveillance solution that includes hardware, software, and services. The major software component of SSS is IBM Smart Surveillance Analytics (SSA), which provides an open framework for event integration and correlation, highly specialized searches based on multiple object attributes, and advanced real-time alerts. Conceived and designed by IBM Research, the capabilities of SSA allow for real-time decision making and post-event analysis of people and activities, thereby enabling the convergence of physical and IT security.

Highlights

Surveillance techniques may be used to manage security risks and business issues more effectively across a variety of organizations, including public safety, airports/seaports/railways, retail stores, and financial institutions.

Today's Surveillance Challenges

In today's environment, virtually every municipality, agency, educational institution, mass transportation center, financial institution, utility plant and medical center must plan for threats and protect the security of its property, employees, customers, citizens and IT infrastructure. Additionally, businesses in every sector face challenges in protecting their customers, employees, and assets while working to reduce operating costs, improve productivity and increase profit as well as customer satisfaction. Examples of security risks and business issues that may be managed more effectively using surveillance methods include:

- **Public Safety/Security:** Increased threats have caused many government agencies to deploy surveillance cameras and sensors, providing situational awareness around critical facilities. School campuses must deal with protecting entry and exit points, maintaining IT network security, preventing vandalism and avoiding authorization issues.
- **Airports/Seaports/Railways:** Mass transit businesses and agencies must protect passengers, staff, and physical assets from terrorist threats and security breaches, and adhere to regulatory requirements.
- **Retail Stores:** The retail industry monitors establishments to reduce fraud, theft, and administrative errors. Retail stores also use video and analytic information to determine the effectiveness of promotional displays and count people in various areas to optimize store layouts as well as sale effectiveness.
- **Financial Institutions:** Many banks have 24-hour human surveillance requirements for inside operations and Automated Teller Machines (ATMs). Surveillance and analytics are being used to reduce threats of robbery as well as fraud. Many banks are consolidating security controls across bank branches by monitoring video, voice and transactional information from a central command and control center.

Highlights

Analog Video Surveillance has served as a deterrent to crime, as well as a means to record people, movement and events. However, factors such as high cost, poor image quality, and limited ability to distribute information have contributed to the need for this technology to evolve.

An Evolution of Surveillance

Organizations have used surveillance for decades as a deterrent to criminal activities such as theft, fraud, and violence. In the last ten years, surveillance technology has been developed that not only helps organizations detect and respond to threats sooner, but also helps them focus on improving business operations. The three generations of surveillance are often described as:

- Analog
- Digital
- Smart or Intelligent

We will explore each of these in greater detail to help you better understand how we arrived at today's environment and where we plan to go in the future.

Analog Video Surveillance

Video surveillance has typically involved the placement of analog video cameras in sensitive or strategic areas of a particular business, coupled with closed-circuit television (CCTV) for live monitoring. This serves not only as a deterrent to crime, but also to record the movement of people and property. Mobile methods of video surveillance, such as mounting cameras in patrol cars, buses and trains are also often utilized to record events.

The use of analog video cameras results in the creation of hundreds of videotapes that then must be viewed by security guards. The cost of employing security personnel to monitor hundreds of cameras, in addition to storing a high volume of videotapes can be prohibitive. Additionally, videotapes can have poor image quality and deteriorate over time.

More importantly, studies have shown that a person assigned to sit in front of a video monitor for several hours a day and watch for particular events is an ineffective security system. Tests have demonstrated that after only 20 minutes

Highlights

DVS provides enhanced functionality and business value for clients, enabling them to manage and safeguard their organizations more effectively.

of watching and evaluating monitor screens, the attention of most individuals has degenerated to well below acceptable levels.¹ Monitoring video screens is both boring and mesmerizing. Furthermore, manual searches of tapes can take too long to provide vital information needed to assist in investigations.

Also, video can often only be viewed from a single end point that is not shared. This limits the ability to distribute information across an enterprise, which could help minimize company-wide threats and alerts. Finally, analog video systems cannot extract business intelligence from security data.

Digital Video Surveillance

Today, video surveillance remains as vital as ever, but it assumes a new role. The emergence of digital video, IP video cameras, networked video recorders, web video, consumer cameras and video-based intelligence is opening up a wide range of applications providing enhanced functionality and business value to organizations.

Digital video surveillance (DVS) enables clients to establish effective risk management strategies that will help them manage and safeguard business information and technology assets, anticipate vulnerabilities and risk, and maintain timely access to information.

Many organizations have piecemeal solutions, and are challenged by having multiple systems that do not communicate with each other. Often, the separation of IT and physical security does not allow organizations to take advantage of existing IT infrastructures and applications, such as identification (ID) management and transactional systems that may already be in place. Operating totally separate, disparate systems for IT and physical security is not only less effective, but also more labor intensive and costly.

¹ *The Appropriate and Effective Use of Security Technologies in U.S. Schools*, Mary W. Green, Sandia National Laboratories, September 1999

Highlights

A DVS solution can help organizations increase their return on security investments in a number of ways, such as reducing time previously needed to monitor and review tapes, or potentially preventing incidents through enhanced intelligence gathering.



Figure 1. Digital video surveillance drives intelligence through integration, which can enhance your ability to respond.

Migrating to a DVS solution will help address some of the limitations of a tape-based analog system. DVS can help organizations achieve better returns on their security investments by:

- Enabling real-time detection and potential prevention of security incidents through enhanced intelligence gathering
- Using event-based viewing for investigative purposes, eliminating the need to chronologically review videotapes
- Reducing the need to monitor video cameras and change tapes
- Increasing product security by deterring potential shoplifters and monitoring staff
- Providing evidence against fraudulent claims
- Increasing indoor and parking lot security

Smart Surveillance

Smart surveillance, intelligent video surveillance, video analytics, intelligent video and intelligent analytics are typical names used to describe the concept of applying automated signal analysis and pattern recognition to video cameras and sensors, with the goal of automatically extracting “usable information” from video and sensor streams.

Highlights

IBM Smart Surveillance Analytics is a key component of IBM Smart Surveillance Solution, providing capabilities that enable real-time decision making and post-event correlation of people and activities.

IBM Smart Surveillance Solution (SSS) helps optimize security by integrating hardware, software and services within an organization, thereby enabling the convergence of physical and IT security. An integral part of SSS is a software component developed by IBM Research known as IBM Smart Surveillance Analytics (SSA), which provides capabilities that enable real-time decision making and post-event correlation of people and activities.

Usage Scenarios

IBM Smart Surveillance Analytics has many unique features to help clients manage security issues and prevent problems before they occur, such as:

- **Open framework**—A comprehensive security and surveillance plan may involve multiple modalities of events captured from various video analytic technologies, non-video sensors and event systems like TLOG in the retail environment. SSA has been designed with an open framework that enables event-based surveillance and can make the integration of events simple and easy.
- **Behavior factory**—Many vendors provide a set of behaviors, such as “large fast vehicle” and “stopped vehicle.” These behaviors have been designed with a limited customer set in mind. SSA’s ability to alert based on “database indexed metadata” of all events occurring across a series of camera feeds allows the user to customize behaviors to their environment through an easy-to-use interface.
- **Attribute search**—The intelligent video industry has approached surveillance based on a limited set of known threat models; hence, the emphasis on “tripwires and abandoned objects” and very limited functionality to support investigation of “unknown threats.” SSA, through its unique and patent pending metadata search, supports a wide range of queries on events that may or may not have been previously defined as alerts. This is possible because SSA is capturing metadata on event activity, not just on pre-defined alerts.

Highlights

The SSA framework can be quickly and easily customized to accommodate the requirements of specific clients and industry segments.

- **Customized solutions**—The vast majority of intelligent video vendors have built analytics and user interfaces based on a limited set of customer requirements. While the core analytics technologies remain relatively stable across industry sectors and clients, the usage patterns for surveillance and the business processes differ vastly across sectors. The SSA framework allows easy incorporation of business processes into the user interfaces and solutions for different industry sectors. One of the key goals of SSA is to support rapid customization of the framework to suit the needs of specific clients and industry segments. Customization is achieved through the following methods:
 - **Business Partner integration**—Integrating technical capabilities from IBM Business Partners to enhance the overall functionality available to the client.
 - **Event integration**—Capturing and consolidating events that are generated in the client’s environment into SSA.
 - **Solution customization**—Customizing the solution to include the business constraints of the client’s application.
 - **Analytic customization**—Customizing the video/sensor analysis capabilities to address the specific needs of the client.
- **Web-enabled solution**—Most existing solutions are not truly networked, which makes remote event monitoring, event centralization, and remote system management very challenging. The SSA framework allows the remote configuration of analytics and the remote monitoring of events to take place easily and effectively.
- **Scalable system**—Most vendors have limited scalability, both in terms of processing per channel and aggregation of events from a large number of cameras. SSA exploits industry standard TI-DSP technology’s increased scalability for large scale solutions, providing guaranteed scalability from a surveillance information management perspective.

Highlights

The capabilities of SSA can be applied across a variety of industry segments to address numerous security and business issues.

SSA can be used to provide solutions to multiple clients across multiple industry segments, including municipalities, retail, financial institutions, intelligence agencies and the public sector. These solutions can be grouped broadly under the following categories:

- **Security solutions**—SSA is used to provide real-time alerts for known “threat conditions” and investigative capabilities. Organizations that can potentially benefit from this functionality include municipalities, airports, seaports, railways, critical facilities, retail and financial institutions.
- **Intelligence solutions**—Capabilities of SSA provide an indexed repository of events consolidated across cameras, which can be used to understand patterns of activity across a facility or campus, and to identify activity that deviates from these patterns. Organizations such as universities, public safety and intelligence agencies can use this unique feature, which is designed to allow events and patterns of the past to be used to help predict potential threats.
- **Operational solutions**—SSA’s capability to track human movement is used to study and improve the operational efficiency of a facility. Applications include counting people entering a facility, managing wait-times at a service line, and understanding traffic patterns. Industry segments include retail stores and airports.
- **Transportation solutions**—SSA’s capability to track vehicles on roads is used to better understand traffic patterns, report blockages, provide real-time traffic assistance and support traffic planning. This capability can be leveraged by cities, airports and seaports.

Highlights

SSA provides the unique capability to carry out efficient data analysis of video sequences, either in real-time or recorded video. It is designed to allow monitoring and analysis of real-world events via sensors like video cameras, radar or audio inputs.

- **Entertainment solutions**—The capability of SSA to track people can be used at sporting events to generate enhanced statistics, visualizations and interactive gaming. Clients that may be interested in this capability include casinos, sporting leagues and television stations.

IBM Smart Surveillance Solution Architecture

As stated above, the integral software component of SSS is IBM Smart Surveillance Analytics. The analytic framework of SSA is comprised of two core components: Middleware for Large Scale Surveillance (MILS) and Smart Surveillance Engine (SSE). They will be discussed later in this paper.

SSA provides the unique capability to carry out efficient data analysis of video sequences, either in real-time or recorded video. Based on open standards-based middleware, the open standards-based software platform is designed to allow monitoring and analysis of real-world events via sensors (like video cameras, radar or audio inputs).

All SSA functionality is Web-based, allowing virtually “anytime, anywhere” access to both real-time and historical event data from the system.

Figure 2 shows the high-level conceptual architecture of IBM Smart Surveillance Solution. It illustrates how Smart Surveillance Analytics integrates with existing video cameras and capture systems to provide:

- Video/sensor analytics capabilities
- A framework for integrating event information from multiple related sources
- A framework for building client-specific solutions drawing upon the video and sensor events and integrating these into the client’s business process

Highlights

Two key functions provided by SSA are the ability to create real-time alerts and perform user-driven queries.

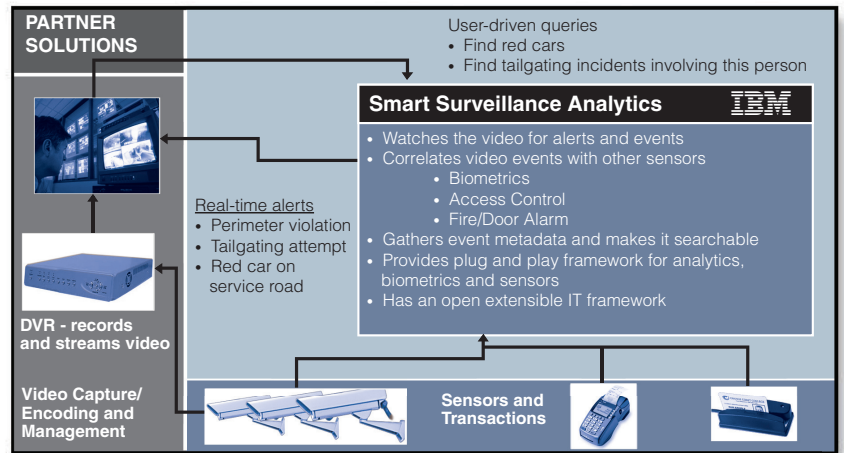


Figure 2. IBM Smart Surveillance Solution—a conceptual architecture

SSA provides the following types of functions to the end user:

- **Real-time alerts:** Users can specify “alert definitions” that include multiple conditions from a single camera/sensor or across multiple cameras and sensors. SSA uses its analytics capabilities to evaluate events occurring in relevant sensors against the alert definition. Each time the “alert definition” is triggered, SSA can provide the user with prompt notification of the event.
- **User-driven queries:** Users (both human and applications) can use SSA to perform content-based queries against event metadata that is archived by SSA. For example, SSA can retrieve all events from a camera where “a red car” was driving across the parking lot.

Highlights

The SSA framework supports user management, metadata indexing and search services and extensibility services.

Figure 3 shows a high-level description of the functionality provided by SSA.

- **SSA Framework**—The SSA framework provides a number of capabilities needed to configure, manage and operate a large system with cameras, sensors and events from other transactional systems. The framework supports:
 - User management: These services provide the ability to add users to the system and provide selected access to cameras.
 - System management: These services include the ability to manage cameras, analytics engines, maps, and metadata content generated by the analytics.
 - Metadata indexing and search services: These services leverage the metadata captured by the Smart Surveillance Engines (SSEs), parse and insert the metadata into a relational database and provide applications with the web services needed to search and retrieve events from the metadata. This metadata database becomes a full index of not only alerts, but of all events.
 - Extensibility services: These services allow for the extension of the base data model to incorporate new sources of information, thus allowing for easy customization of SSA to meet client needs.

Highlights

There are several types of video analysis technologies, each of which involves sophisticated algorithms that process the video/sensor signals to extract information and structure the information to support the real-time alert and search functionalities of SSA.

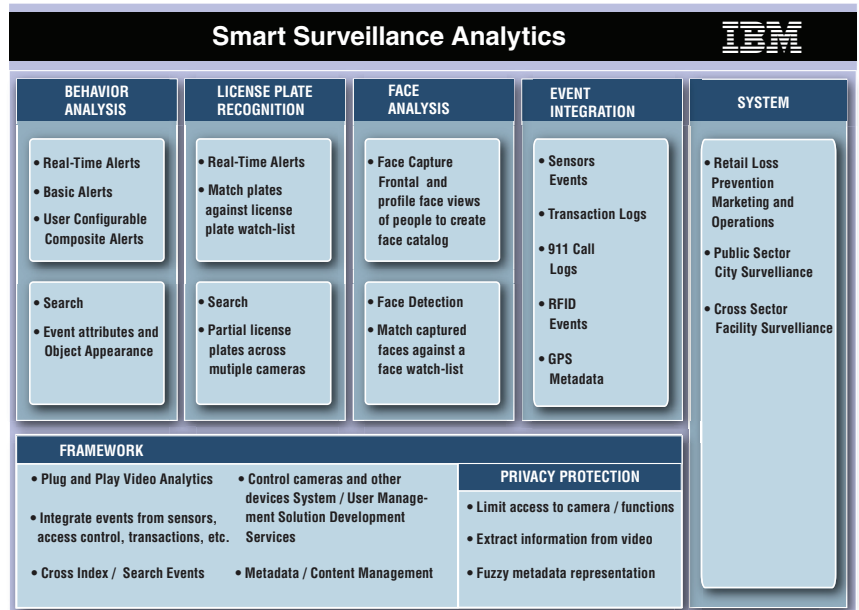


Figure 3. SSA Functionality

- SSA Functionality:** There are several types of video analysis technologies that are part of SSA. Typically, each of these analytics involves sophisticated algorithms that process the video/sensor signals to extract information and structure the information to support the real-time alert and search functionalities of SSA. The video analysis technologies are:
 - Behavior analysis:** These analytics are intended to analyze the movement of objects within the field of view of a camera. This is based on the ability to detect and track multiple moving objects across the camera, classify these objects, and extract various object attributes like color, shape and size. The extracted information is used to provide a variety of alerts while recording information from all events (for example, motion detection, tripwire, abandoned object) and search functions (for example, find red cars).

- License plate recognition (LPR): This analysis capability is tailored to detect the presence of text within a given video frame, and apply optical character recognition technology to extract the license plate number. LPR needs to be customized to the character set (for example, English, Arabic), style, format and appearance of the license plate, which varies significantly across geographies. In order to correctly operate, LPR requires a minimum resolution across the license plate and adequate illumination and viewing angle.
- Face detection: This analysis capability is designed to automatically detect images of human faces from the video. The face detection capability creates an index in the video and marks the time at which the face was present in the video. The system generates a key frame to represent the face, thus producing a catalog of faces for all the people who appeared within a camera field of view (approaching the camera.)
- Event integration: This capability allows the integration of events from the analysis of other sensors (like automatic door sensors, HVAC sensors, audio) with event streams from other IT systems (like point-of-sale, telephone call logs). Once integrated, the event information can be cross-correlated to video-based events like behavior analysis, LPR and face detection.

Figure 4 shows the software architecture of SSA.

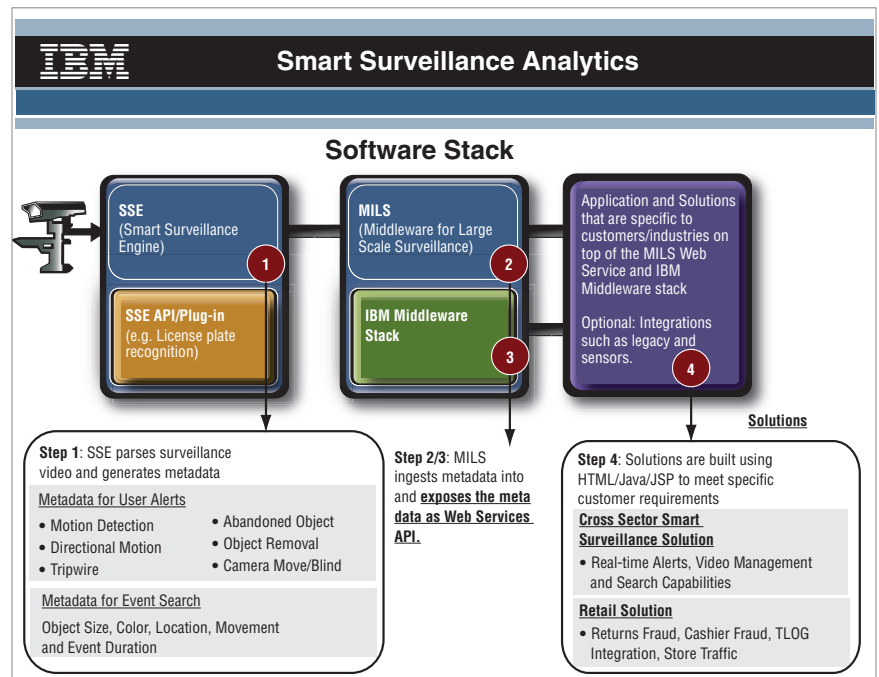


Figure 4. SSA Software Architecture

SSA has the following core components:

1. **Smart Surveillance Engine (SSE):** The Smart Surveillance Engine (SSE) is a C++ framework for capturing events that are observed by sensors such as cameras. Every physical camera in your environment is assigned to an analytic engine running on an SSE server. One SSE Server can handle multiple cameras. In general, SSE is designed to process streams of video in real-time, automatically extracting event (activity in the camera's field

Highlights

SSE is designed to process streams of video in real-time, automatically extracting event (activity in the camera's field of view) metadata and evaluating user-defined alerts.

of view) metadata and evaluating user-defined alerts. The specific user functionality associated with each camera is based on the profile which is configured for use by the analytic engine associated with the camera. The following profile types are available:

- Behavior analysis (Outdoor Far-field, Outdoor Near-field, Indoor Tracking)
- Face detection (Face Tracking, Sensitive Face Tracking)
- License plate analysis (via integrated IBM Business Partner technology)

The information extracted by SSE from the camera's field of view is used to classify objects according to the profile type, providing metadata on object type, object size, object speed, etc.

SSE alerts are conditions which have been specified by the user as being of interest. SSE supports both basic video alerts and compound metadata-based alerts. Currently, we support the following basic video alerts:

- Motion detection-detects motion within a specified region of view
- Tripwire-detects directional crossing of user-defined tripwire
- Region-detects certain specified behavior within a specified zone, such as entering, leaving, starting and stopping
- Abandoned object-detects when an object has been left behind
- Object removal-detects when an object has been taken away
- Directional movement-detects when objects are moving in a user-specified direction
- Camera move/blind-detects changes in camera state such as movement or obstruction
- Camera movement stop-detects when a pan-tilt-zoom (PTZ) camera stops moving

Highlights

MILS provides system management, user management and various extensibility services, including a web services application programming interface (API).

2. **Middleware for Large Scale Surveillance (MILS):** Each installation of the IBM Smart Surveillance Solution, which includes SSA, has a MILS Server. MILS is a J2EE framework application built around IBM's DB2®, WebSphere® application server and MQ platforms. In addition to metadata management, MILS provides system management, user management and various extensibility services, including a web services application programming interface (API).

MILS can help provide consolidated backend data management capabilities and store metadata that describes key activities discovered while ingesting video data. It can also create and manage a full index of the ingested video data. This index has a full set of event attributes that can be searched to support forensic analysis. The index attributes can also be used to define composite metadata-based alerts by combining the metadata in various ways to define complex behavioral patterns.

MILS operates on top of a software middleware stack, either IBM WebSphere Remote Server (WRS) or IBM Central Site Server. Both provide a middleware platform with a J2EE application server called WebSphere Application Server Network Deployment, integrated with:

- WebSphere MQ for an assured message delivery component
- DB2 Workgroup Server Edition as a relational database management system

3. **Applications:** These are mainly web applications (HTML, Java, JSP, applets, Javascript) which use the web services enabled by MILS to provide the functionality needed by the user.

Highlights

Implementing IBM Smart Surveillance Solution, which includes Smart Surveillance Analytics, offers many benefits to industries, including the potential to increase return on investment (ROI).

IBM Smart Surveillance Analytics can also allow administrators to add new metadata schemas to the system, thus enabling new analytic engines to send sensor/event metadata. The metadata from all analytic engines can be consolidated allowing users to search across modalities. These advanced indexing capabilities offer a unique and powerful differentiator from virtually all other available surveillance solutions.

Return on Investment (ROI) by Industry

Implementing IBM Smart Surveillance Solution, which includes Smart Surveillance Analytics, offers many benefits, including the potential to increase return on investment (ROI). ROI successes fit into three categories: managing risk, growing the bottom line and growing the top line.

ROI highlights in various industries include the following scenarios:

1. Retail

In today's retail environment, product shrink dramatically affects the top and bottom line. Globally, on average, 1% to 3% of all retail sales are affected by product shrink, due to conditions including crime, employee fraud, and damaged goods.² This results in a significant impact on retail margins, especially for those businesses running on a 1% to 3% margin. IBM Smart Surveillance Solution can serve as a loss prevention tool as well as a source of retail intelligence data. It can provide video technology to help manage profit and loss at the cash registers, under the cash registers and throughout the store. Retailers can implement SSS to determine promotion effectiveness, cashier monitoring and people counting. Grocers can use the technology to help reduce Bottom of Basket (BOB) losses. One grocer has reduced BOB by more than 80%, integrating IBM's optical recognition and an IBM Business Partner Point-of-Sale (POS) system.³

² 2004 National Retail Security Survey Final Report, 2005

³ "LP/POS Integration Success", Integrated Solutions for Retailers, April 2007

2. Public Safety

Police departments have utilized DVS solutions to reduce the number of court appearances, legal fees, and reporting time. Several cities have installed in-car video with Wi-Fi wireless capability in their police cars, which allows officers to instantaneously review videos when necessary and to react faster to potential crime situations. On campuses, DVS systems offer lower cost and improved security capabilities over traditional analog systems.

3. Banking

In the banking industry, integrating existing security systems (including access control, CCTV, DVR, NVR, intrusion systems, fire, HVAC, video walls, alarms, building management systems, and analytics) can significantly increase management of security data and simultaneously reduce operational costs. By linking security data with business transaction data, benefits can be realized in the following banking areas: ATM/check fraud prevention, teller position monitoring, cash counting operations, queue monitoring and effectiveness of branch space utilization.

4. Railroad

In the rail industry, manual inspection of cars as they leave the railyard can be decreased up to 50% by implementing DVS for video checking.⁴ DVS analytics can be used to perform safety checks, and alerts can be sent when visual checks reveal unsafe cars.

⁴ *Digital Video Surveillance and Security for Railways*, IBM Corporation, July 2007



5. Airports

In airports, the data stored in security systems has significant potential for improving business results. Implementing an IBM DVS system can help increase ROI by reducing the need for continuous viewing of TV monitors and searching hundreds of videotapes. Also, linking security data with business transaction data provided by self-service kiosks and gate scheduling can help increase ROI. Time and cost savings can also be realized by collating management data from multiple systems in a single operation.

Summary

In this paper, we have discussed the evolution of surveillance and how today's technology can be used to improve physical security as well as provide business information to enhance decision-making and increase productivity.

With real-time analytics capabilities, the DVS services from IBM can open up a wide array of new applications that go far beyond the traditional security aspects of surveillance systems.

IBM, along with selected IBM Business Partners, offers a wide range of applications and services appropriate to various client environments. Leveraging best-of-breed offerings from these Business Partners helps IBM design and integrate innovative, award-winning solutions in the areas of physical and data security. As a leader in digital video surveillance solutions, IBM can help you effectively utilize today's technology to help you distribute the right information to the right people at the right time.

For More Information

To obtain more information about digital video surveillance solutions from IBM, speak with your IBM representative or visit:

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