Virage Security & Surveillance White Paper

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Introduction

Security and surveillance operations have become an increasingly important consideration at a corporate, national and global level as organizations strive to protect individuals and mitigate against risks posed to public and corporate assets. While surveillance operations and observation form an integral part of any security strategy, the ability to understand, analyze and interpret the significance of information gathered as part of surveillance operations is a fundamental requirement for all security environments today. Increasing volumes and types of data, including video footage, camera stills, vehicle registration plates, traffic records, police databases, immigration records, telephone conversations and transaction reports form part of security operations and point to the need to adopt comprehensive strategies which encompass all security data.

Virage Security and Surveillance supports every stage of security and surveillance operations, providing an extensive range of advanced recognition and recording systems as well as capabilities for instant and post event retrieval and analytics. A flexible and entirely modular architecture allows customers to select products according to their specific requirements to create tailor-made, highly sophisticated security systems. All products may be used either as individual components on a standalone basis or multi-linked to each other to create a centralized control and management center.

Combining world leading technologies from security, infrastructure and video specialists, Virage offers one of the most sophisticated security and surveillance solutions in the world. Pioneering advanced recognition technologies originally developed for the security services lie at the heart of Virage Security and Surveillance and provide a strong foundation for a sophisticated product range which includes: Digital/Network Video Recording (DVR/NVR), Automatic Number Plate Recognition (ANPR), Intelligent Scene Analysis System (iSAS), Electronic Point of Sale Monitoring (EPOS), Container Surveillance and Management System (CSM), fingerprint and audio analysis and 3-D face recognition.

As part of the Autonomy Group, Virage has been fully integrated with Autonomy's award winning technology - offering enhanced analytical capabilities. Autonomy's unique technology allows organizations to monitor vast quantities of information from disparate sources, understand all data gathered at a conceptual level and place each piece of information in context with other known intelligence. By automatically understanding the inherent meaning and potential significance of any piece of information, Autonomy's technology brings fresh, intelligent insight and immediate analytical capabilities to all security environments.

Digital/Network Video Recording

As an integral part of crime control policy, social control theory and community consciousness, CCTV is a defining feature of today's society and a powerful tool used by corporations and governments worldwide. High quality digital and network recording facilities are a critical component of any successful CCTV strategy to ensure that potentially vital images are captured and retained safely for further analysis. While CCTV footage is popularly believed to play an important role in crime detection and prevention, in order for a system to be truly effective, robust recording equipment is a priority.

Moreover, simply capturing and storing images indiscriminately does not, in itself, constitute an effective solution, DVR/NVR technologies which merely capture and store footage fall desperately short of the levels of complexity required by most security and surveillance environments. Virage Security and Surveillance DVR/NVR offers organizations state of the art recording technology together with advanced retrieval functionality for rapid image recall to ensure that key images can be located quickly and easily for further analysis. Bringing fresh intelligence to digital and network recording and transmission, Virage DVR/NVR is sophisticated enough to alter its function in response to changing circumstances and distinguish between different types of behavior and alarm. With storage capacity expanding into petabytes, the ability to record at full resolution across multiple channels and prioritize its activity dynamically, Virage Security and Surveillance offers a new breed of DVR/NVR.

Dynamic Resource Prioritization

Surveillance staff can link straight to live images from multiple cameras and locations linked to a DVR/NVR unit. All images captured and retained by Virage DVR/NVR resolve fine detail and allow users accessing images, either on the fly or in retrospect, to analyze detailed, high resolution images.

Unlike other systems which require extensive configuration by an administrator or are limited to one simple recording option, Virage Security and Surveillance DVR/NVR is entirely flexible and can perform multiple recording functions simultaneously and reconfigure itself dynamically based on an alarm. Increasing the frame recording rate, switching between cameras or switching between storage buffer types, ensures resources are prioritized dynamically according to demand.

In order to ensure a commitment to recording and storing high quality images likely to be required for post event analysis, cameras may be configured to change their frame recording rate according to certain pre-defined conditions. For example, when integrated with Virage Security and Surveillance Intelligent Scene Analysis System (iSAS), if certain activity is detected within the field of view, such as someone leaving a bag unattended, DVR/NVR can be programmed to react to this alarm and automatically increase the recording frame rate prior to, during and after the event. Virage DVR/NVR can be configured to respond to multiple categories of alarm including Video Motion Detect (VMD), digital, Automatic Number Plate Recognition (ANPR) and Intelligent Scene Analysis System (iSAS):

- *VMD: DVR/NVR can be configured to react once motion is detected within a specified scene or particular area within a scene.*

- *Digital: these can be generated by physical movements including the opening of a barrier or door; when such movement is detected, DVR/NVR can be configured to respond automatically.*

- *ANPR/iSAS: when integrated with Virage Security and Surveillance ANPR or iSAS systems, pre-defined alarms are automatically relayed to the DVR/NVR unit to ensure appropriate images are captured and stored upon recognition of certain vehicles or behaviors.*

Figure 1 – Virage monitors multiple locations simultaneously

Audio

A key requirement for many remote surveillance systems is bi-directional audio transmission which enables surveillance staff to communicate with persons remotely. Virage Security and Surveillance DVR/NVR supports bi-directional audio transmission, and where required, units can be equipped with audio recording facilities which will synchronize video from an associated camera to achieve full "lip-sync". Typically used when identifying and challenging intruders, audio transmission and recording capabilities offer enhanced facilities for remote surveillance operations.

Storage Capacity and Principles

Virage Security and Surveillance DVR/NVR offers extensive storage capabilities and hard disk drive (HDD) capacity which can be adapted to suit individual project requirements. While storage costs have decreased significantly in recent years, and Virage continues to lead the market in providing comprehensive storage facilities, in most circumstances, it is neither necessary nor desirable to store large quantities of irrelevant footage.

Virage DVR/NVR can be configured to prioritize storage of images accordingly. All images are stored to a HDD which is integrated within each DVR/NVR unit. The system uses HDD circular buffers working on a first-in first-out (FIFO)

principle to ensure that there is always storage capacity available for new images. Buffer size determines the maximum length of storage period available, so by using multiple buffers of differing sizes, images can be stored for different lengths of time. Virage can record and store all background images routinely for a specified time, e.g. for 7 days or 30 days, dependent on buffer size and where required, store footage from immediately before, during and/or after an event on a separate buffer so that it is available for retrospective analysis.

Storage levels are monitored automatically to make sure that all necessary images are captured and archived correctly. Should storage be consumed faster than expected, either as a result of a higher than expected number of events or due to a miscalculation, the user will be automatically alerted to this in order to ensure that images may be continually recorded and stored according to requirements. In order to increase the amount of images stored within any given DVR system, the compression level of images may be modified at any time, thereby making the system extremely flexible to changing requirements.

Extensive Archive Options

In general, the size of storage buffers will determine the length of time for which any images are retained, but where specific images need to be retained for an extended period of time, DVR/NVR provides multiple levels of archiving:

- *Snap shot archiving: involves saving single images as a standard bitmap to the archive directory or CD - saved images may then be printed or emailed where it is necessary for other parties to gain access to the images.*
- *Streaming: enables users to review images from multiple cameras individually e.g. if an incident was suspected to have taken place between 3.00am and 3.15am an operator would be able to retrieve, store and review all the images from that time period individually using streaming.*
- *Major event download: used when large quantities of images must be retained for further analysis - using a local area network (LAN) connection and software provided by Virage, images can be copied bit for bit onto another network computer with no impact on the current performance of the DVR/NVR system.*

Advanced Retrieval Functions

An extensive range of retrieval features ensure that users can locate and retrieve relevant images quickly and easily. As well as searching and retrieving images by time and camera, where users wish to search by alarm category such as by iSAS alarm, users may specify multiple parameters in order to retrieve specific events within a given alarm – for example, find images of dangerous vehicle maneuvers within a specific scene.

Electronic Point of Sale Monitoring

With internal employee theft on the increase and current systems falling short of the mark, businesses need to implement new measures to detect and prevent fraudulent activity. Surveillance systems need to be able to capture the right information at the right time and, where necessary, analyze it intelligently to uncover correlations which might otherwise not be apparent. Systems currently in place often rely heavily on human surveillance (see page 15) however, this type of surveillance alone is highly ineffective. Businesses need solutions which complement their efforts, maximize the efficiency and efficacy of POS surveillance and reduce losses.

Virage Security and Surveillance EPOS delivers DVR/NVR of the highest quality. Combined with synchronous capture of cash register transactional data, Virage EPOS offers retailers the most versatile and efficient surveillance and retail management system available. Full data capture, including time synchronized image and transactional data together with centralized reporting and management enable retailers to monitor multiple locations simultaneously and correlate results from multiple cash registers. Multiple site EPOS data and daily reports can be sent to and managed from a central location and remote access enables off site reports and investigations. These features make Virage Security and Surveillance EPOS the most comprehensive solution of its kind available on the market today.

Theft and Fraud: The Challenge

According to recent national statistics, theft costs retailers around 5% of their annual turnover with 20% of theft attributable to credit card fraud and employees responsible for over 50% of shrinkage. Research has shown that whilst 19% of firms with fewer than 15 employees have experienced staff fraud, this figure more than doubles to 48% for businesses with over 36 staff. In addition, the U.S. Department of Justice estimates that insider theft is growing at 15% annually. More alarmingly, research has shown that 75% of internal theft is undetected.

Theft and fraud, clearly extremely detrimental and a huge issue to companies of all sizes worldwide, show no signs of easing. Detecting fraudulent activity is a key concern, particularly amongst petrol stations, confectioners, tobacconists, newsagents, convenience stores, supermarkets, pubs and clubs and fast food outlets. More than ever companies are seeking new measures to combat this illegal activity, however, many businesses still only rely on manual surveillance techniques alone. Research carried out indicates that businesses lost as much as $60 billion in 2005 as a result of not using anti-fraud software. That aside, even where software solutions have been implemented, in many cases these solutions fall short of requirements and subsequently fail to adequately combat illegal activity.

Live Point of Sale Monitoring

Virage Security and Surveillance offer solutions to suit all retail applications and budgets. Virage Electronic Point Of Sale (EPOS) enables effective stock management by reducing stock losses and increasing profits. Virage offers an unrivalled combination of high quality DVR/NVR and EPOS monitoring in one package. Designed to detect and deter fraudulent activity at the Point of Sale (POS), EPOS synchronization associates POS transactional data with DVR/NVR

CCTV footage. In this way, Virage EPOS acts as an early warning system by alerting surveillance staff to suspicious or illegal activity at the cash register, as it happens. Rules-based keyword matches, based on given requirements, allow alerts to be triggered at the POS when transactions such as voids, refunds, discounts and cashback are activated.

Figure 2 – Virage EPOS monitors activity at the Point of Sale.

Intelligent Post Event Analysis

In addition to providing live EPOS monitoring, Virage enables playback of prerecorded images. DVR/NVR data can be analyzed post event by reviewing data stored on the HDD. All data is stored in a database at the time it is created and can be quickly and easily located as and when required for future analysis. Retrospective investigation options support a full range of retrieval options e.g. transaction data, video images or multiple parameters. Transaction data is searchable by:

- *Date*
- *Time*
- *Product*
- *Price*
- *Till Number*
- *Other search parameters (including multiple parameters) based on pre-defined rules e.g. void plus cashback*

An intuitive, user-friendly interface with drag and drop features makes the system easy to use and means minimal training is required. Users can search and view records based on transaction data and where CCTV images are available, these will be displayed along with the transaction data. Similarly, users can search for an image or video segment and then request the transactional data for this image/segment. Transaction data and video footage are always available but users are able to choose whether that information is displayed along with what they've searched for. Under no circumstances is transactional data automatically burned onto the video imagery as this could render the CCTV footage useless. In the event that users wish to display transactional data with the video footage, users can choose to overlay transactional data on top of video footage. Where multiple cameras are in use, users can search all cameras simultaneously through a single interface, or simply narrow their search to results from a specified camera.

Advanced analytics, such as clustering (identifying related groups of data), enable the discovery of trends and correlations across the entire data set, providing the ability to spot unusual activity spanning multiple cash registers which may have otherwise gone undetected. Conceptual analytics which use unique pattern matching techniques to detect underlying trends and anomalies in any given data set, enable retailers to gain greater insight into all transactional data and corresponding video images (for further information on these features please see page 22).

Architecture, Configuration and Training

Virage Security and Surveillance EPOS is fully scalable and suitable for both small and large scale deployments. Virage EPOS is integrated with the DVR/NVR to provide comprehensive recording and analysis functionality. Up to 16 cash registers can be attached to each DVR/NVR unit and multiple DVR/NVR units can be seamlessly linked together to increase system size where necessary. Separate interfaces are available to allow connection with, for example: cash registers (300 types), Automatic Teller Machines (ATM's), coin scales and sorters, car park ticket machines, weigh bridges and toll booths. Virage are continually innovating and creating new interfaces to suit changing customer requirements. In addition, data can be accessed both locally and remotely providing the basis for the most versatile, flexible and remote surveillance and retail management system available today.

Virage Security and Surveillance ensures that storage requirements are actively managed for optimum performance by automatically overwriting all captured images after a specified time. Pre-event recording can be triggered to ensure that images which precede a significant event can be appropriately captured and stored for later analysis. These storage techniques ensure that all images surrounding potentially significant activity can be kept without the need for extensive storage capacity. Predefined events can be configured within Virage EPOS to increase the recording frame rate on key words or hard wired alarm inputs. Frame capture can be configured to automatically increase where the systems detects unusual or suspicious activity - this means important visual information is not lost at a critical moment. HDD performance remains unaffected by both search and playback features. The storage capacity of the installed system will determine how long images are kept. In addition, limits can be set on individual users to limit how far back they are able to search through footage.

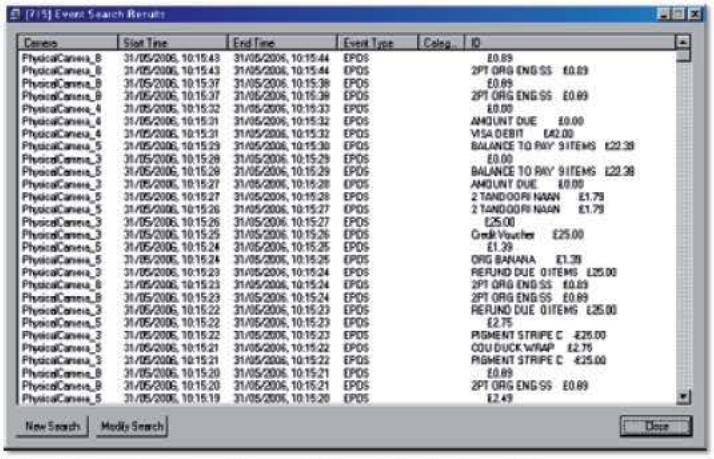

Figure 3 – EPOS retrieves transactional data which can also be viewed alongside imagery from multiple cameras if desired.

Container Surveillance and Management

It has been estimated that there are up to 19 million containers currently in transition globally and that traffic is increasing at a rate of about 10 percent annually. Given the ever increasing volumes of traffic, vehicle and container identification and tracking has never been so important to the logistics industry. Not only do organizations need to know where containers are and when they will be delivered but also other more detailed information such as what condition the containers were in at various stages throughout their journey and who and where they were accessed along the way. Virage CSM enables comprehensive vehicle and container identification and tracking in logistics environments; from seaports and inland container terminals to rail container terminals. Automation within Virage CSM removes the need for costly additional manual input and makes the identification, tracking, control and management of logistic processes highly efficient. A unique combination of core technologies and superior analytical capabilities give Virage CSM the power to provide added intelligence which can be used to improve future operations and deliver significant benefits to businesses.

Advanced Vehicle and Container Recognition Systems

Virage Security and Surveillance Container Surveillance and Management (CSM) is a world leading vehicle and container recognition system. This highly sophisticated tool enables businesses to keep track of the ever-increasing volumes of cargo that flow through transport hubs such as seaports, inland container terminals and rail container terminals. Virage CSM automatically captures vehicle and container information, including:

- *Vehicle number/license plate*
- *Container(s) ISO numbers*
- *Container type*
- *Container damage recording*
- *Site and gate location*
- *Date/time*

Not only does Virage Security and Surveillance CSM enable businesses to keep an accurate record of exactly when and where containers pass through certain points in the transport network; in addition, through high quality digital video recording and management, Virage CSM keeps track of what condition containers are in at various stages of their journey throughout the world. By capturing this cross section of data, Virage provides complex cross referencing for 24/7/365 operations. CSM can significantly increase traffic efficiency as the system works on moving vehicles as well as those which are static. CSM works on standard 20,30,40,45 and 20 + 20 ft containers.

Core Technologies

Virage Security and Surveillance CSM employs world-class Optical Character Recognition (OCR) for container and number/license plate recognition. Fully automated OCR in conjunction with high quality recording of digital video images offers users the ability to centralize all of this data and cross-reference it with, for example, container inventories in order to repurpose the information quickly and efficiently for further analysis and use. Core technology means Virage CSM is able to offer advanced automated functionality such as automatic clustering, profiling, alerting and hyperlinking in conjunction with web distribution of data and video. This provides Virage Security and Surveillance with unique, superior analytical capabilities and added intelligence (see page 22 for further information on functionality and integration).

Architecture

Due to the open architecture design of CSM, the system is able to communicate and interface with on-site management systems, eliminating a wide range of manual processes leading to significant return on investment. Virage Security and Surveillance CSM is fully compatible with existing information systems and can be set up to work as a web, intranet and/or other application. Virage's web access features mean customers can view data quickly and easily over the web when they need. The system is fully scalable and easily managed using intuitive administration panes. CSM can be integrated with Virage Command and Control as well as with other Virage applications such as ANPR and iSAS for superior intelligence and analytical capabilities.

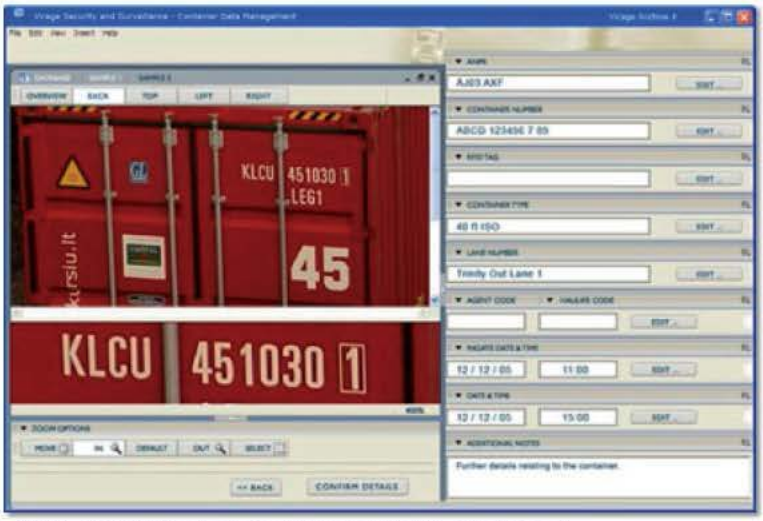

Figure 4 – Virage CSM tracks container data such as number plate, cargo number and even container condition.

Automatic Number/License Plate Recognition

Automating the processes of identifying and tracking vehicles has valuable applications for both commercial and law enforcement purposes. The ability to identify vehicles in all conditions and trigger appropriate actions automatically is a key requirement in many environments ranging from car park surveillance and monitoring forecourts to traffic law enforcement and border controls. With the capability to integrate with multiple databases and automatically cross reference and correlate identified license plates with other data, Virage Security and Surveillance ANPR offers the most sophisticated technology for automatic vehicle identification and tracking. When integrated with Virage DVR/NVR, ANPR provides a comprehensive, end to end solution which encompasses every aspect of vehicle recognition and tracking together with advanced recording, retrieval and analytical capabilities.

Compatible with existing CCTV systems, Virage ANPR can recognize and record number/license plates including international plates even at speeds exceeding 100 MPH, and where necessary, trigger an appropriate response. Example applications include: identifying stolen vehicles, car park surveillance, traffic law enforcement and access control such as monitoring drive throughs, filling stations, toll booths and border controls. With inbuilt digital and network recording capabilities and the ability to integrate with multiple repositories such as police databases and traffic records, Virage ANPR is suitable for all vehicle surveillance operations.

Advanced Automatic Vehicle Identification and Tracking

Full integration with multiple databases and the ability to correlate recorded number plates with other data, such as stolen vehicle registers, traffic and law enforcement records, credit card transaction reports and customer records place Virage Security and Surveillance ANPR capabilities way beyond traditional plate recognition systems. Virage's comprehensive approach, which automatically cross references each vehicle identified with any other data sources available supports efforts to understand and interpret the potential significance of certain behaviors.

In addition to assisting in traffic law enforcement and vehicle identification, Virage Security and Surveillance ANPR has numerous commercial applications. For example, renowned retailers use Virage ANPR to ensure their most loyal customers receive outstanding levels of customer service. At the entrance to the car park, ANPR automatically detects loyalty cardholders as they enter and automatically assigns them a convenient parking space. As well as enabling retailers to offer special customers a more personalized service, Virage ANPR provides valuable insights into customers' shopping habits such as how frequently they visited the store over any given time period. Virage Security and Surveillance ANPR is also used to streamline logistics operations, for example, loading and unloading goods at distribution centers. By automatically matching vehicle number/license plates with information held in local databases, Virage ANPR triggers entry authorization and automatically directs vehicles to designated bays where relevant documentation will be waiting so that unloading/loading can commence immediately.

Core Technologies

Neural Network (NN) based OCR techniques lie at the heart of Virage Security and Surveillance ANPR capabilities, supporting advanced character recognition in all conditions. Unlike template matching used by other systems, which is dependent on receiving high quality images in order to identify number plates successfully, Virage ANPR utilizes NN based OCR techniques which provide much greater tolerance for matching poorly defined characters. Virage ANPR can also be integrated with Virage Command and Control for further advanced functionality (see page 22).

High Performance in All Conditions

Automatic format checking places each plate reading in context by verifying the identified number plate against typical templates in any given territory. By taking multiple readings of each plate and using sophisticated probability matching techniques to analyze and calculate the likelihood that any given reading is correct, ANPR is able to recognize number plates extremely accurately.

Figure 5 - Multiple image grabs, automatic format checking and sophisticated probabilistic matching techniques produce highly accurate plate reading results.

Virage Security and Surveillance ANPR can accurately identify number/license plates even in the most demanding conditions, such as when visibility is low due to adverse weather or poor light conditions. When combined with an infrared illuminator, Virage ANPR is even able to recognize number plates at night. In addition, ANPR is able to capture and identify square, inverse, borderless and foreign plates entirely automatically. Where required, adjustments to contrast, plate size, country number/license plate format, skew and rotation settings can be made by the operator to fine tune the system in order to achieve optimum performance in specific conditions. The system can be configured to trigger prerecording where required to ensure important images are captured and stored for later analysis (see page 22). In addition, Virage enables recording via digital triggering to achieve a 100% capture rate.

Database Integration and Action Assignment

Number/license plates may be added into the database, along with any associated metadata, such as registered vehicle owner's name, home address and driver history by importing a text file into the database. Once vehicles are entered into the databases, actions can be associated with each plate by assigning a code to each entry; this ensures that once a vehicle is correctly identified, pre-defined instructions will be followed. Virage enables integration with third party databases. Database records can be individually entered or imported as a one off, or periodically integrated – this enables mass data transfer from the third party system to the Virage system. For example, where Virage Security and Surveillance ANPR is used for access control, a code can be assigned to authorized cars to trigger a barrier to be raised so that authorized vehicles can gain access. Where an unrecognized vehicle is detected, the system could be configured to play a WAV file which would refuse the vehicle entry and trigger a live audio/video connection which would be relayed to security staff instantaneously for verification. Where required, different codes and actions may be assigned depending on what time or date any given vehicle is identified: for example, when employee vehicles are detected approaching a staff car park, the system can be configured to raise the barrier if it is a weekday, but if it is during the weekend, the system can be configured to allow access, but also record footage of the vehicle and notify the driver's supervisor that they were onsite during the weekend.

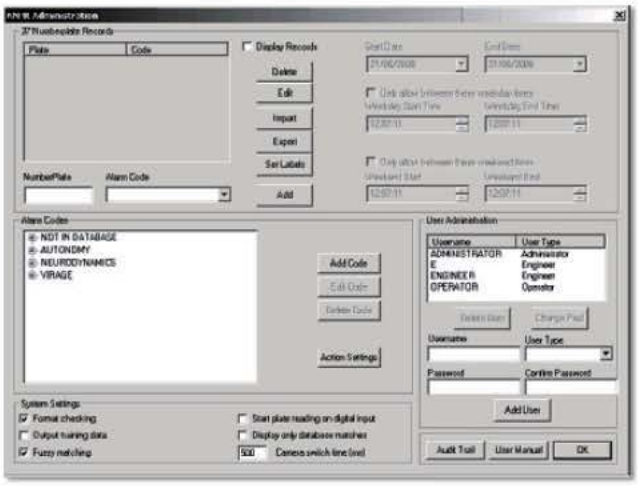

Figure 6 – Assigning alarm codes and actions to number plates using the administration screen.

The list below provides a sample of typical actions upon vehicle recognition:

- *raise barrier*
- *change traffic lights*
- *display LCD text*
- *play WAV file*
- *alert supervisor via SMS/email*
- *deny access*
- *open live video/audio connection*
- *trigger recording via DVR/NVR (including pre-recording)*
- *store image of vehicle/plate/driver*
- *increase frame rate for higher quality recording*

Number/License Plate Searching and Retrieval

An intuitive user interface ensures that information captured by Virage Security and Surveillance ANPR is easily accessible and that key events can be readily identified by security personnel. Virage DVR/NVR provides extensive event viewing and searching options including instant plate matching, partial plate matching as well as a full range of options to search by specific parameters including camera, date, time, alert code, plate and category. Where multiple cameras are in operation, users can search all cameras simultaneously through a single interface, or if desired, narrow their search to results from a specified camera. Users can create 'hot lists' of specified vehicles they wish to track closely and compare any identified number/license plate to predefined lists or perform full vehicle and driver database matching in order to match identified vehicles with any entry within the database.

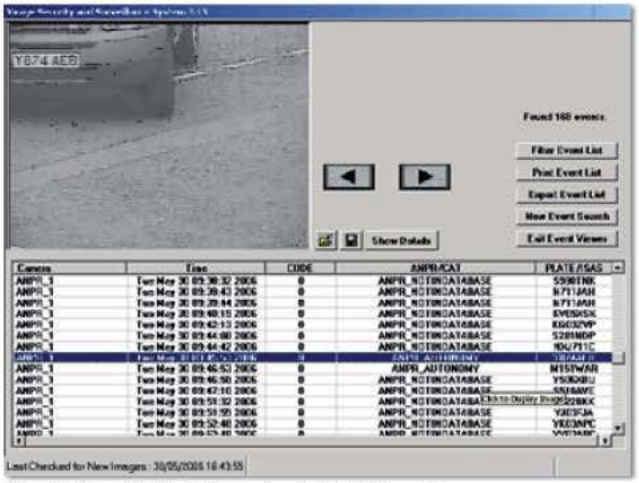

Figure 7 - Virage ANPR facilitates search and retrieval of key events.

If images from an overview camera are available, these can be displayed adjacent to the footage of the number plate enabling operators to view driver or vehicle images alongside number plate images. Any metadata associated which has been included in the database entry, such as registered vehicle owner, address and traffic records is presented alongside each recognized number plate to enable operators to gain instant visibility into the history of any identified vehicle. For optimum performance and in order to maximize storage, Virage Security and Surveillance employ advanced techniques (see page 2).

Intelligent Scene Analysis System

As risk management becomes an increasingly important consideration for international corporations and governments alike, so does the need for effective CCTV systems and technologies which allow organizations to detect and understand the significance of observed behaviors more accurately. In order to maximize the investment in such services and improve the standard of surveillance operations, organizations should invest in systems which enable them to interpret and understand the significance of images gathered as part of CCTV surveillance operations more closely. Virage Security and Surveillance iSAS has been proven to increase the efficiency and efficacy of surveillance operations dramatically by automatically detecting, analyzing and interpreting all activity within a field of view. Trusted by key law enforcement agencies, governments, retailers and major transport service providers, Virage iSAS significantly complements all surveillance operations.

Traditional CCTV Surveillance

The overall efficacy of any CCTV system is entirely dependent upon the extent to which individuals are able to recognize and respond to the video surveillance signals presented to them. Human error accounts for virtually all failures to respond appropriately to video surveillance signals. Recent industry figures suggest that up to 85% of on-screen information goes unnoticed once a system operator has been on duty for a mere fifteen minutes, rendering a typical CCTV system desperately inefficient.

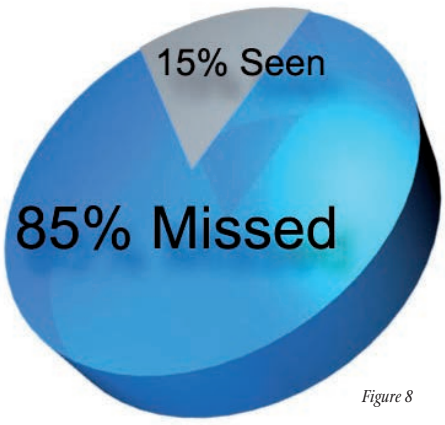

Figure 8

Multiple duties and discontinuity in personnel, such as shift changes and high staff turnover, contribute to reduced efficiency and dramatically decrease the quality of surveillance operations. In addition, failures in concentration and consciousness can impact greatly. Human concentration span typically wanes after 45 minutes according to recent scientific studies. Typical surveillance shifts lasting up to 12 hours far exceed the normal human concentration span and contribute significantly to failures to identify and respond to unusual behaviors. Even when an operator is fully focused on a surveillance task, a number of low level failures in the human consciousness are responsible for failure to detect important activity:

- *Change blindness: visual disruption within a scene e.g. switching between multiple screens or blinking, can result in vital information being missed.*
- *Inattentional blindness: when the brain is focused on one particular activity, for example, counting vehicles leaving a car park, it will frequently become unable to respond to other stimuli.*
- *Attentional blink: when the brain shifts its focus from one activity to another, events can be missed in the time it takes to transfer concentration from one activity to the other.*
- *Repetition blindness: repeated sequences of similar items can cause some events to be missed.*

Virage Intelligent Scene Analysis

Virage Security and Surveillance developed Intelligent Scene Analysis System (iSAS) in consultation with key security agencies to improve the efficiency and efficacy of surveillance operations. Complementing existing surveillance procedures, Virage iSAS enables organizations to anticipate and detect potential threats or illegal action, instantly and automatically, and take proactive preventative action against any security concerns. Ideally suited to complex multi-camera environments such as airports, major transport networks and government buildings, iSAS enables organizations to monitor multiple locations simultaneously and, most importantly, monitor for different behaviors within each scene.

By detecting suspicious behaviors, identifying potential security threats and providing alerts entirely automatically, Virage enables CCTV operators to focus their activities on behaviors which require attention and verification by a security professional. A full range of features including advanced VMD, non motion detect, object sizing, object tracking and object counting enable surveillance officers to understand the potential significance of any motion or object within view.

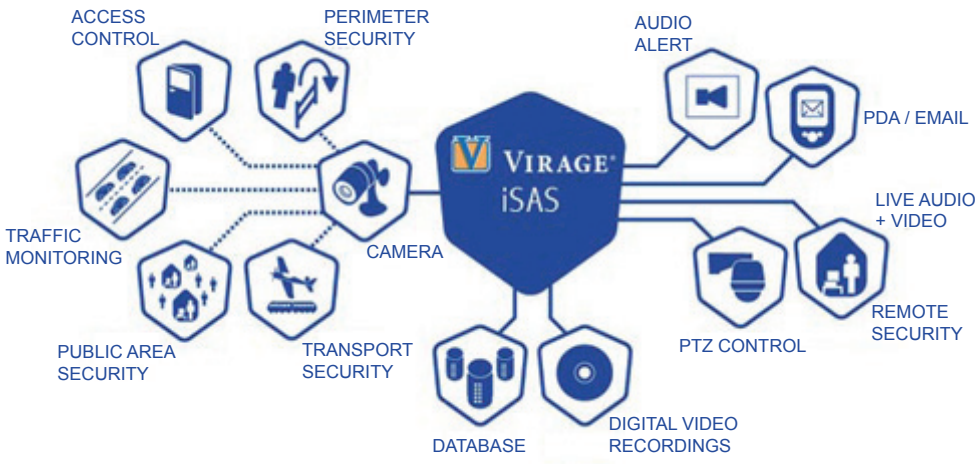

Figure 9 - iSAS is suitable for a range of environments and easily connects to existing third party systems.

Instant Recognition and Analysis

In order to correctly identify suspicious behavior, it is essential that any object or movement is placed in context. Using advanced techniques, iSAS identifies and categorizes objects in a scene by size, shape, color, speed, direction, location and time of day and, over time, builds up a history of these objects. By then putting each object and motion in context, using techniques such as comparing object histories, VMD, non motion detect, object sizing, object tracking, object counting and behavioural analysis, Virage Security and Surveillance iSAS enables surveillance staff to interpret the threat that any given object or motion may pose more accurately. iSAS performs multiple levels of recognition and analysis on video data from simple tasks such as identifying movement within a scene through to complex behavioral analysis. Full details of recognition techniques are detailed below.

Video Motion Detect

VMD is the most basic form of recognition which identifies movement of objects within a specified field of view, for example, a person entering a restricted area.

Figure 10 – iSAS monitors traffic on a motorway.

Non Motion Detect

Non Motion Detect (NMD) has the ability to recognize static objects within a scene such as unattended baggage in an airport. Users may set parameters to define the types of object which should be detected and also define the length of time an object should be static in order to be classed as a stationary object.

Figure 11 - Using advanced NN based OCR techniques, iSAS NMD can identify stationary objects which may constitute a threat.

Object Sizing

Detecting the size of an object or a group of objects in a field of view alerts surveillance staff to situations which may require a response. For example, where iSAS is used for monitoring traffic flow, if a traffic jam is detected, surveillance staff can be alerted immediately and if necessary, an additional lane could be opened to ease congestion.

Object Tracking

In addition to identifying objects, Virage Security and Surveillance iSAS can track objects entirely automatically between multiple cameras. While an object remains in a field of view, it is tracked automatically using the coordinate information to control a Pan Tilt Zoom (PTZ) camera.

Object Counting

By automatically categorizing identified objects into known types, Virage iSAS can generate counts for different categories. Multiple counts can also be configured, for example, iSAS can count the number of cars entering a car park and the number of cars leaving simultaneously.

Behavioral Analysis

Behavioral analysis offers the most advanced form of scene recognition. Once an object has been identified and is being tracked by Virage Security and Surveillance iSAS, the system is capable of employing more sophisticated techniques for further analysis. Virage iSAS is able to differentiate between various scenarios by placing all identified behavior within the context of normal behaviors as specified by the user. By applying an associated motion history to an object, iSAS can automatically undertake complex behavioral analysis in order to recognize unusual or suspicious activity and alert surveillance staff to this immediately.

Figure 12 - iSAS uses object histories to identify unusual or suspicious behaviors.

Training and Configuration

As each surveillance and monitoring environment is unique, Virage Security and Surveillance gives organizations the flexibility to set and refine their own definitions as to what behavior could constitute a potential security threat and also define the precise action to be taken once a potential threat has been correctly identified. Training and configuring an iSAS system does not require any specialist input from Virage and may be performed by any competent system operator.

Using an intuitive user interface operators can train the system, using live or prerecorded images, to recognize unusual behavior which may present a threat and establish multiple definitions for multiple locations. For example, the user can train the system to trigger an alert to unattended baggage in the arrivals hall of an airport which would automatically result in a prerecorded message over the PA system. Baggage being held by airline staff however would not trigger such a response. Virage supports a range of training methods including:

- *Non alerting content: where the system is introduced to video containing no specific events.*
- *Alerting content: involves training the system on specific events contained within the video.*
- *Simulating alerts: by inserting objects into the scene which can then be used to generate example events.*
- *Alert verification: the most sophisticated training procedure consists of using pre-generated alerts in order to enhance system training and improve overall performance. By allocating a series of pre-generated alerts into specific categories, such as examples of suspicious and unsuspicious behavior, the system can be configured to identify behaviors more accurately. Such user verification allows the system to build up a model of known behaviors and gives the system greater insight into what constitutes usual and unusual behaviors.*

Figure 13 - iSAS can be trained to recognize specific behaviors and trigger alerts as required.

To allow organizations to monitor a wide area against a set of diverse criteria, Virage Security and Surveillance iSAS can be applied to any new or existing CCTV system and loaded up with different configurations for different cameras or camera positions. Moreover, iSAS can be configured to identify multiple categories of alarms within a scene at the same time, each with its own set of specified alert actions. Other configuration options include masking a scene so that objects within a certain perimeter are not detected, masking alerts generated by any object within a specified area, setting time or occurance limits on alarms generated per incident and full customization of results notification with the inclusion of metadata associated with system, camera, data, time and alarm code.

Architecture

Virage Security and Surveillance iSAS can be used on a stand alone basis for alarm recording only or fully integrated with Virage DVR/NVR and/or other Virage products for advanced functionality. In addition to providing continuous surveillance and alerting through advanced instant intelligent scene analysis, full DVR/NVR integration enables organizations to store images for post-event analysis. An intuitive user interface enables operators to retrieve recorded video quickly and easily in order to find specific events and carry out forensic analysis retrospectively.

Figure 14 - An intuitive user interface enables operators to search and retrieve images easily.

A flexible architecture and modular approach makes iSAS suitable for point of activity and remote surveillance operations. iSAS monitors direct analogue feeds from the cameras so once an event is detected, alerts can be streamed over the network to a remote location. Such a system provides optimal resolution for identifying objects within a scene whilst only requiring minimal bandwidth to relay the events and any associated alerts to a remote location. For remote surveillance operations, video can be streamed in MPEG4 or MPEG2 format and analyzed at a remote location. Where alerts are generated from the video stream, these can be processed locally or relayed to a remote location. Using this technique, banks of iSAS may be switched using dynamic prioritization across any number of cameras in order to support large scale remote surveillance operations.

Biometrics and Audio Recognition

Audio Recognition

Virage Security and Surveillance speech recognition technology enables security organizations to search files in video, radio and telephony systems instantly. Virage's speech technology is fundamentally different; whereas other technologies adopt a simple phonetic approach using only acoustic information, Virage achieves a higher level of understanding through language modeling.

Language modeling involves concept extraction in conjunction with acoustic-phonetic methods to achieve significantly greater accuracy and better results. Simple acoustic-phonetic methods alone fail to achieve good speech to text translation. The acoustic-phonetic approach doesn't differentiate, for example, between "can I" and "can eye". In this example, where the desired option is "can I", Virage's speech technologies employ intelligent probabilistic language modeling to understand the context of what is being said and in this way select the appropriate option "can I".

Virage's audio recognition functionality includes:

- *Speaker independence: the system is trained on a large balanced corpus of data encompassing many different variables such as different accents or male-female pitch and tone - this means the acoustic models are speaker independent. The solution works out-of-the-box with no manual training although customization for specific accents or speakers can be done*
- *Extensive vocabularies: there is no arbitrary limit on vocabulary size*
- *Speaker identification: Virage audio recognition can be trained to enable individual speakers to be identified*
- *Word spotting and phrase recognition: Virage can search audio by standard keyword as well as conceptual methods. Conceptual searching returns references to conceptually related information ranked by relevance or contextual distance.*
- *Patented Autonomy technology: reduces CPU and memory usage for increased speed of operations and improved performance*
- *Support for both high quality audio such as broadcast as well as telephony*

Fingerprint and 3D Face Recognition

Virage Security and Surveillance also offer other powerful biometric identification tools in addition to audio recognition. The Virage fingerprint recognition solution uses the same established fingerprint minutae techniques as a police fingerprint expert – this enables fingerprints to be located and matched against a database of millions in order to successfully identify individuals. In addition, Virage Security and Surveillance provides facial recognition technology where other biometrics, such as fingerprint analysis, are not suitable. Facial recognition techniques are often used for example where suspects need to be identified at a distance and/or non-cooperatively. However, 2D face recognition has always had fundamental limitations with regard to posture, expression and lighting. Virage Security and Surveillance employ superior three-dimensional recognition techniques rather than the traditional 2D facial matching process for optimum performance.

Command and Control

Given the complex nature of security and surveillance operations and the vast amount of heterogeneous data which requires aggregation and analysis, the need for advanced technologies which can make sense of information and alert the relevant parties to crucial intelligence has never been so great. The Virage Security and Surveillance Command and Control infrastructure enables all Virage products to interact seamlessly. It has been specifically designed to allow easy integration of third party equipment such as alarm panels, display units etc. Although certain Virage products can be deployed for simple functions such as standalone capture and archive, in order to perform more advanced functions, Virage provides three levels of Command and Control for a range of different environments and needs; from simplistic rule-based models to highly complex, intelligent solutions based on conceptual analysis.

Level I

Virage Command and Control Level I offers a simple rule-based solution. Any number of Virage products can be connected with the Command and Control system which performs as per instructions pre-defined by a systems administrator. For example, if Virage DVR and EPOS were set up with Level I, the system could be programmed to highlight particularly unusual till transactions such as large sums of cashback on the logged till transaction data. Virage NVR and CSM might also be deployed with Level I to monitor traffic at a port and could be trained to raise a barrier for particular vehicles whilst disallowing entry for others.

Level II

In addition to performing simple rule-based functions, Virage Level II Command and Control handles logical interactions between disparate pieces of data. Level II offers additional capabilities which enable instant analysis and logical calculations to be carried out on data flows. Virage DVR, iSAS and Command and Control Level II might be used for example, to monitor vehicle speeds between points; by identifying the same object and calculating the distance between the two points, the system could calculate distance traveled within a given time frame and therefore what speed the vehicle/s must have been traveling at. Another example might be deploying NVR and ANPR to monitor carpark usage in multiple locations and calculate usage percentages based on initial numbers collected i.e. the system could highlight that the central carpark has the highest usage at 50% whilst north and south car parks have 20% and 30% usage respectively.

Level III

Virage Command and Control Level III has been fully integrated with Autonomy's technology to deliver a complete state-of the-art solution for all security and surveillance needs no matter how complex. Through this intelligent platform, Virage offers users the ability to form a conceptual understanding of information and recognize potential threats automatically. Autonomy's core technology is used by some of the most prestigious intelligence and defense agencies worldwide including the U.S. Department of Homeland Security, U.S. Department of Defense, The British Ministry of Defense, the Olympic Games Security Committee, National Nuclear Security Administration and numerous other intelligence and defense agencies worldwide. One of the key reasons organizations choose Autonomy, is its ability to discover "the unknown" which has a significant impact upon the efficacy of many world-renowned security agencies.

Autonomy's technology forms a conceptual understanding of all forms of unstructured, semi-structured and structured data be it visual, auditory or alphanumeric in character. At its core, the technology uses a combination of Bayesian Inference and Shannon's Information Theory to automatically extract the key concepts from any piece/s of information. As a mathematical platform, it is not constrained by the limitations of linguistic or rules-based models. Distinct concepts, ideas and behaviors are exposed within any data set on the basis of mathematically derived coherence and not rigid conformity to predefined structures or characteristics. This enables the technology to recognize the potential threat for the first time, both at a tactical and strategic level, without prior training or insight. Operationally, this results in an intelligent surveillance infrastructure capable of instantly and automatically fusing vast quantities of heterogeneous data, identifying interrelationships, spotting important trends and alerting surveillance officers to this vital intelligence. Additional functionality can be seamlessly integrated into the system in order to perform further advanced data fusion operations.

Additional Level III Functionality

Conceptual Retrieval and Search

Content can be searched simultaneously in any language and any format, wherever it is stored. Search options include: Conceptual Search, Natural Language Retrieval, Query By Example, Refine By Example and Cross-Language Search. The technology retrieves and returns references to conceptually related information and results are presented with summaries and hyperlinks to similar information instantly and automatically.

Hyperlinking

This feature enables automated matching and identifying of similar pieces of information. Powerful automatic hyperlinking functionality identifies vital relationships between information, enabling intelligent contextual cross-referencing of content without the need for user input.

By completely removing the requirement for manual input through its use of intelligent conceptual and contextual association, Virage ensures the instantly generated links are always up-to-date and highly relevant to users. For example, if CSM and Level III Command and Control were deployed to monitor vehicles and containers at a port, the technology could make intelligent associations between information in a police database, imagery captured by DVR/NVR and data within CSM, to report stolen or illegitimate vehicles and/or drivers. The technology might also link to further intelligence of other illicit activities being performed by these vehicle drivers. Not only are people kept informed of the latest, most relevant information but also - in this way - duplication and time spent navigating for information and overall costs are significantly reduced:

- *Reduces the cost of maintaining unstructured information within any environment*
- *Reduces the time taken to navigate to related information*
- *Reduces duplication of effort*
- *Keeps people informed and right up-to-date*
- *Retains browsers or consumers on a website through dynamically recommending further content and products*

Clustering

Automatic Clustering enables organizations to analyze large sets of document data or even user-profile information and automatically identify inherent information clusters and consequently trends and themes. Clustering provides organizations with instant high-level visibility of the knowledge base, eliminating knowledge gaps and enabling the organization to react quickly where necessary. For example, using Level III Command and Control, number/license plates captured by ANPR could be clustered and matched against a police database. In this way, potential correlations within data - such as repeat offences committed by the same driver attempting to disguise his actions by using different vehicles - could be uncovered and action taken to prevent future occurrences of the same instance. Other benefits include:

- *Instant high-level visibility of the knowledge base*
- *Automatically identifies information trends and themes*
- *Eliminates knowledge gaps*
- *Optimizes an organization's information flow*
- *Reacts to information changes*

Powerful visualization tools make it easy for users to understand and interpret data sets. Virage provides two intuitive Java-based user interfaces to make clusters visible:

- *2D Cluster Map: is used to identify conceptual similarities and differences between clusters and display them in 2D. Based on Java Server Pages (JSP), the landscape is generated from the inter-relationships between clusters and the documents contained within those clusters. Designed to provide a single overview of the clusters contained within the data, clusters that are close together correlate to higher degrees of similarity, whilst dissimilar clusters are situated further apart.*
- *Spectrograph: this user interface displays the relationship between clusters in successive periods and sets of data. Clusters are presented as a JSP-based 3D spectrograph whereby the x-axis represents information over time (enabling users to visualize how clusters develop over a given time period), whilst the y-axis represents the range of concepts defined within the knowledge base (see figure 15).*

Figure 15

Automatic Profiling

Automatic Profiling can be used by organizations to accurately understand individuals' interests based on browsing, content consumption or content contribution. By generating a multi-faceted conceptual profile of each user, based on both explicit profiles (agents) and implicit profiles (click-through and submission), the feature creates a very current understanding of user interests without the need for any explicit input on their part. Profiling facilitates and speeds up surveillance operations as it enables vital intelligence to be delivered to the user without their needing to actively search for it.

Personalized Agents

Personalized Agents can be set up to proactively deliver highly relevant, accurate information to users. Agents can be trained to look for conceptually related themes from concepts a user defines either implicitly or explicitly as part of their profile. By continuously monitoring live information streams and matching relevant, conceptually related content against profiles, Agents can uncover data that may potentially hold new significance for intelligence operations – increasing overall knowledge and improving response rates. Through its automatic approach, Agents assist surveillance staff to monitor activity and information which may potentially be critical and which might otherwise have been missed or required significant investigative processes to discover.

Intelligent Alerting

Advanced Alerting functionality monitors information in order to automatically and instantly alert users to information which may be of interest to them based on their profile or the agents they have set up. For example, if a surveillance officer had set up agents to monitor and deliver information on a particular suspect, if the agents detected similarly conceptually related activity being discussed by another person, the system could automatically trigger an alert in order for security staff to be alerted to this potential correlation. Instant alert mechanisms could be web interfaces, e-mails, SMS or digital alarms amongst others.

Architecture

Command and Control Level III is a scalable, data agnostic platform, independent and modular by design, which can very simply be integrated into current or legacy systems to provide automatic conceptual analysis across all data and deliver a unified intelligence exchange across all platforms. The system acts as an intelligent 'information brokerage' to aggregate, combine and deliver a unified stream of information from a variety of applications and sources even when they fail to share a common language, data structure and format, logic or communication methodology. Command and Control Level III can seamlessly be integrated with Virage Security and Surveillance EPOS, CSM, ANPR and iSAS for advanced intelligence operations (see figure 16).

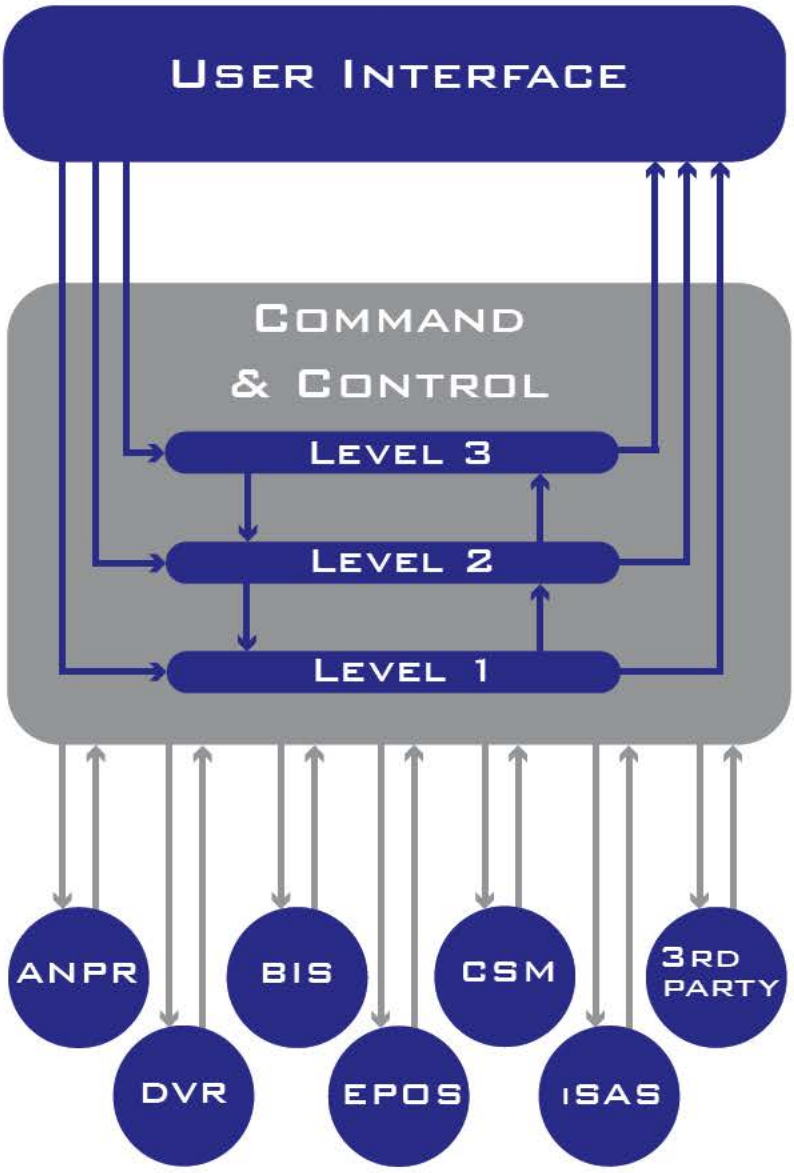

Figure 16

Security

Maintaining security and ensuring only authorized personnel gain access to sensitive data is key to almost every organization. Increasingly complex IT environments mean there are often several systems in place each requiring a different set of authentication procedures. Virage's infrastructure exactly mirrors the security entitlement required to deliver the right information to the right people according to who is entitled to see it. The world's largest and most secure intelligence organizations have deployed Autonomy to safeguard their most sensitive information assets.

Virage Security and Surveillance is unique in its approach to managing and maintaining security and is able to seamlessly integrate with existing third party systems whilst respecting existing security. Advanced methodologies for, user authentication, data protection and verification ensure the right people have access to legitimate data. In addition, advanced functions such as mapping significantly improve system performance within even the largest, most complex environments. These unique advantages make it the number one choice for many leading organizations today.

Security Integration

By integrating fully with other security equipment and procedures, Virage Security and Surveillance respects existing security and enables organizations to respond appropriately and efficiently to ever changing requirements. Virage is a world leader in seamlessly integrating with a range of diverse third-party information sources, such as Documentum, Lotus Notes, Oracle Server or OpenText.

Secure Data Authentication and Personnel Verification

Extensive user authentication, data protection and verification procedures make Virage suitable for the most demanding security and surveillance environments. Virage can provide all aspects of security management including document and intra-document access control against user, group and role level entitlement; this ensures only authorized personnel gain access to sensitive data. Encrypted inter-machine and intra-process communication protocols are woven into the fabric of Virage's modular design at a fundamental level, providing secure transmission of information throughout the architecture. In addition, Virage ensures the integrity of all data captured is preserved through results encryption and image watermarking. Full audit tracking enables authorized personnel to gain immediate visibility into the history associated with any record in the system.

Intellectual Asset Protection System (IAS)

Virage's Intellectual Asset Protection System (IAS) is a comprehensive and modular security architecture that uniquely provides:

- *Asset scalability through Mapped Security*
- *Group membership scalability through Group Servers*
- *Operational granularity via a Document-centric model enabling secure real time operation and total flexibility over your security policies*

Conclusion

Security and surveillance operations are widely regarded as an integral and essential part of today's society. As organizations at all levels, ranging from law enforcement agencies and governments to large corporations and public bodies seek to enhance the security and safety of assets and personnel, security and surveillance technologies are an increasingly commonplace and necessary part of our daily lives.

Growing demands to protect public safety, buildings and commercial assets accentuate the need for robust security and surveillance solutions in a wide range of environments. Consequently, surveillance techniques are increasingly prevalent, especially in many European countries where CCTV systems are now extremely customary. While CCTV cameras in themselves do much to establish public and corporate confidence, the effectiveness of such systems when used in isolation is often limited. Organizations seeking to implement a truly effective and responsible security and surveillance strategy must consider embracing additional systems such as EPOS, CSM, ANPR, iSAS and BIS as well as addressing the way in which data and images obtained from such techniques are recorded and stored. Furthermore, as security requirements become increasingly complex and threats posed to individuals, corporations and nations more sophisticated, it is ever more critical that organizations gain a holistic view of their security and surveillance procedures.

The ability to correlate and cross reference data gained from multiple applications such as ANPR and iSAS with other sources allows organizations to adopt an intelligence led approach to security and surveillance operations. As part of the Autonomy Group, Virage Security and Surveillance offers a comprehensive solution which enables organizations to implement key solutions for specific requirements as well as supporting the overall objectives of their security and surveillance strategy. By incorporating Autonomy's core technology, Virage Security and Surveillance is able to automatically understand and interpret the potential significance of multiple pieces of security data, and correlate that information with other known intelligence to enable organizations to implement comprehensive security and surveillance solutions. Virage's unique approach brings new visibility and intelligence to security and surveillance operations and equips organizations with the technology they need in order to safeguard public, private and corporate assets and respond effectively to security threats today and in the future.

The information contained in this document represents the current opinion as of the date of publication of Autonomy Systems Ltd. regarding the issues discussed. Autonomy's opinion is based upon our review of competitor product information publicly available as of the date of this document.

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