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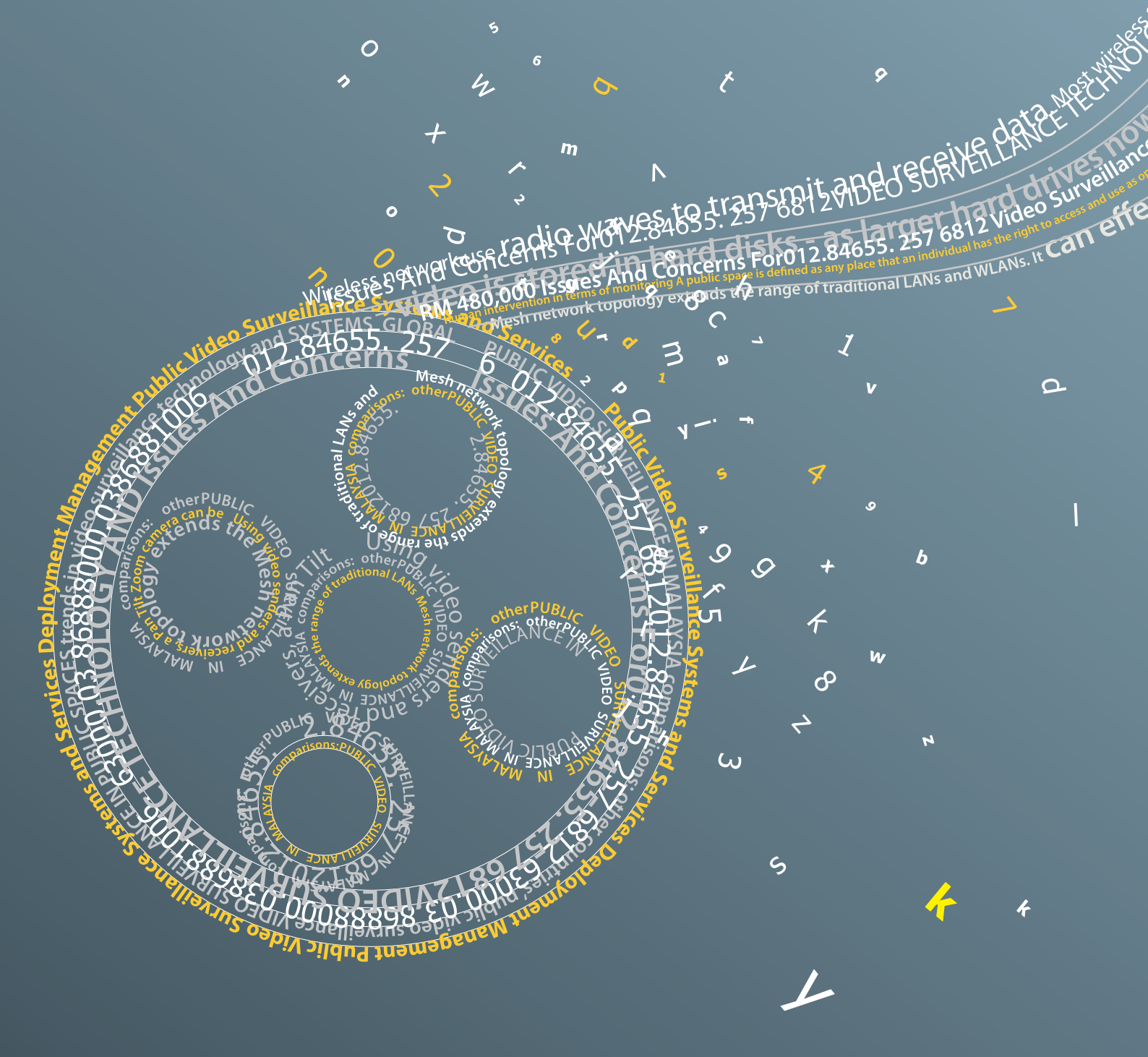
Suruhanjaya Komunikasi dan Multimedia Malaysia
Malaysian Communications and Multimedia Commission

Video Surveillance in Public Spaces



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CONTENT

FOREWORD

On behalf of the Malaysian Communications and Multimedia Commission (SKMM), it is my pleasure to present to our readers the Report on Video Surveillance in Public Spaces.

The report explores a theme seemingly apart from the usual SKMM core communications and multimedia industry research reports. Introducing in this report a review on video surveillance industry and market may be opportune in view of the developments in digitisation and increasingly Internet Protocol or IP-based networks upon which video surveillance is or is going to be supported in terms of delivery platform, hardware and software solutions. It is considered a part of networked content, although deemed as one in closed or private network basis.

The report highlights focal points in video surveillance in the public space, the changing video content delivery and transmission modes and provides an overview of the conditions that warrant the need for public video surveillance. Developments on adoption of video surveillance in public spaces in Malaysia are studied, with comparative analysis from other countries such as United Kingdom (UK), United States of America (US), Australia and China. This is also covered from aspects of not only market and services provided, but also in the area of implementation and accompanying legislations involved.

There is also an analysis on the generic types of management models in video surveillance systems and services deployment in public spaces with discussion on roles and responsibilities of authorities involved in managing the implementation and maintenance.

The report provides a general understanding on the development of video surveillance in public spaces as well as the implementation approaches taken by various authorities. Service providers need to consult experts within the context of their implementation in order to maximise the impact of their services.

A soft copy of this report can be obtained from the SKMM website at:

http://www.skmm.gov.my/what_we_do/Research/industry_studies.asp

I trust this report will provide useful information to our readers. To improve the industry report, we welcome any feedback to assist us in the future. Please send your comments to webmaster@skmm.gov.my

Thank you.

Datuk Dr. Halim Shafie
Chairman
Malaysian Communications and Multimedia Commission (SKMM)

EXECUTIVE SUMMARY

Crime incidents that have taken place around the world have changed government's orientation and spending towards security measures and solutions in the country. Coupled with higher demand for security levels from society and security measures, video surveillance is increasingly becoming a need in fulfilling the wish for greater levels of safety within the community. Other drivers including the decreasing equipment cost and advancement in the hardware systems and software application technologies have also increased the demand for video surveillance systems. Widely used to monitor, observe and analyse a person, a group, activities or even objects, the video surveillance camera will also assist in deterring and detecting potential offenders and crimes and aid police in rendering assistance effectively.

By 2012, the worldwide video surveillance industry market revenue is expected to grow to USD12.72 billion, with Asia Pacific accounting for almost a third of the market at USD3.59 billion. The customer segment for video surveillance industry varies from the government sectors to retail, financial, educational and even industrial sectors while industry competitors are fragmented to include legacy surveillance competitors, digital and networked-focused surveillance competitors and IT-oriented competitors. Overall, the industry is represented by a chain of providers at almost every stage until the end users. Our report here focuses on video surveillance in public spaces. The consumer side is excluded for future reporting.

In a video surveillance system, a Closed Circuit Television or widely known as CCTV is the most commonly used equipment in recording surveillance activities together with Digital Video Recorders (DVRs). But lately, key market trends are that:

- CCTV cameras and digital products are gradually converting to IP cameras and networked or IP networked products;
- Cameras are using Network Video Recordings (NVRs) as opposed to full DVRs and going Internet Protocol (IP)-based;
- Smart and intelligent applications such as Video Content Analytics software are being used; and
- Storage technology has improved in terms of capacity and scalability through the development of Storage Area Networks (SANs).

The video surveillance system architecture today goes beyond a simple system of analogue cameras and CCTVs. Digitisation of images and transmission has opened the surveillance system to digital video recorders, networked video recorders and IP systems on network, supported by a full range of hardware and software solutions such as digital and IP and smart cameras, with Pan Tilt and Zoom (PTZ) capability, time stamping, video analytics, to a range of transmission systems over wired and wireless options in network.

There appears no fixed rate for video surveillance installations or even fixed methods of their implementation. Nevertheless, in a simple ballpark calculation, the UK example for placing a video surveillance system costs RM12,500 per camera. This is higher than the ballpark for Malaysia at RM9,701 per camera.

While video surveillance has been used widely and in public areas as a crime prevention measure in United Kingdom (UK) and other European and western countries since early 1980s and 1990s, the adoption of video surveillance in public spaces in Malaysia is still at an early phase. In Malaysia, CCTV was first implemented by the Kuala Lumpur City Hall (DBKL) with the purpose of monitoring traffic in the city centre using black and white cameras connected with direct cables and leased lines. Subsequently, in 2003, the Ministry of Housing and Local Government issued a directive requiring all public buildings to install CCTV cameras at the car park areas. A Safe City Programme was then initiated by the Government that includes the installation of CCTV cameras as part of the 23 measures to be taken, specifically under Strategy 2 of Target Hardening[1]. Therein, the number of CCTV systems implemented by the local authorities in Malaysia increased state-wide.

Comparative studies show typically two generic approaches in the deployment and implementation of public video surveillance systems and services by various local authorities and councils. Examples from UK and New Zealand show surveillance systems are either deployed solely by local government authorities or in joint partnership between a local government authority and private security service provider.

Additionally, acquiring or leasing of systems by the local authorities is much dependant upon funding provided by respective Ministries and also the cost of overall implementation. In Malaysia, there is a mixed or combination of approach in the deployment and implementation of public video surveillance systems and services by the local authorities whereby some acquire the systems, while others prefer a leasing approach depending on which is more cost effective in the long run. As funding is dependent on the sum of monies awarded by the Ministry, the number of systems deployed is usually in phases.

Therefore, the implementation of a video surveillance system in public spaces is no small task in view of cost and other resources involved amounting to millions in monetary terms. If video surveillance is deemed a necessity after cost saving alternatives have been exhausted such as proper and ample street lighting and similar measures, the other issues on liability and legality to be considered are privacy, workplace surveillance, liability incurred and limitation on disclosure.

Implementing a video surveillance systems in public spaces must be done with integrity and respect for personal privacy and civil liberties. Other consideration and issues are recording of workplace surveillance as cameras installed at public spaces indirectly record the activities of on-street workers and cleaners, the potential risk of liability incurred in the responsibility of ensuring public safety within CCTV areas and limitation of disclosure of video recording and images to other parties.

Moving forward, as technological advancement takes place; the surveillance system is expected to improve dramatically over the coming years especially in the areas of product development, network, investments and systems integration. With that the growth of the market is very much dependant on the advancement of technology and the eagerness of the industry to embrace the system. In Malaysia, the use of video surveillance in public spaces is poised to expand. The wider implementation plan by the local authorities will encourage the overall growth of the industry in Malaysia.

[1] *The strategy outlines guidelines for installation of police post, crime prevention signages, safety mirrors and alarms, cleaning and management of unkempt areas, motorcycle locking facilities, lighting and also the installation of CCTV*

VIDEO SURVEILLANCE

The use of video surveillance is getting instrumental as a crime prevention tool used both in private and public spaces. In many ways, larger metropolitan areas such as London and Perth are equipped with video surveillances; setting precedents in public realm implementations since early 1980s and the 1990s. In contrast, the deployment and implementation approach in public spaces within Malaysian settings is considered relatively new with prevalent developments only in the last four to five years.

Video surveillance can be defined as an activity using a video appliance that enables image capture of video images or extract information to be compressed, stored and transmitted over communication networks and digital data link. It is also used to monitor, observe and analyse a person, a group, and activities or even objects using surveillance camera for reasons including crime deterrence, efficiency in security deployment, discipline and detection of potential offences.

Anticipated Results from Using Video Surveillance Cameras	
Deterrence	Installing surveillance cameras can discourage potential offenders.
Efficiency in security deployment	With such cameras, the authorities can gauge if police assistance is required, thus avoiding false alarms incurring unnecessary police resources.
Self disciplining offenders & victims	Potential victims are reminded of the risk of crime whereas offenders are disciplined through fear of being watched.
Detection	Video recordings of crimes and offences can be used to punish, remove offenders or used as evidence in court.

Source: Community safety practice briefing - To CCTV or not to CCTV? A review of current research into the effectiveness of CCTV systems in reducing crime. Nacro, Crime and Social Policy Section, UK

When deliberating on video surveillance, CCTV is often highlighted since CCTV is one of the earliest and most well-known forms of video surveillance since its availability in 1960s. CCTV is short for Closed Circuit Television which is a television transmission system where live or pre-recorded signals are sent over a closed loop to a finite and predetermined group of receivers, a monitor, sets of monitors or video recorder, either via coaxial cable, telephone wires, fiber-optic, microwave radio systems, Internet or communications satellite. This is in contrast to open-circuit (broadcast) television which is openly transmitted for the public[2].

Video security and surveillance are popular due to technology advancement and affordability; a tool for cost savings as well compared to manual monitoring activities. Whether retailers are monitoring shoplifters or employee theft, police observing traffic, government or city council keeping an eye on pedestrians, combating street crimes and terrorism or individuals protecting their home, the benefit of an effective video surveillance system is obvious.

[2] *Sci-Tech Encyclopedia, Answers.com, VideoSurveillanceGuide.com*

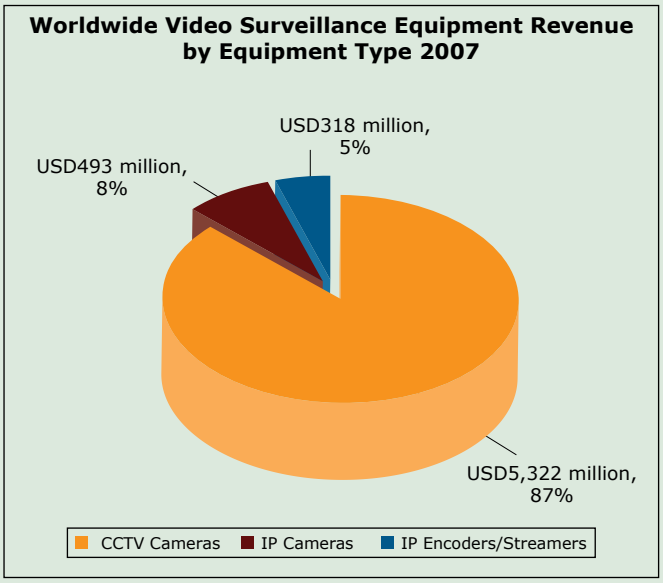
GLOBAL VIDEO SURVEILLANCE INDUSTRY AND MARKET

The video surveillance industry is a segment of the overall security industry and it has experienced accelerated growth due to better pricing and efficiency of cameras, recorders as well as software. Other drivers include:

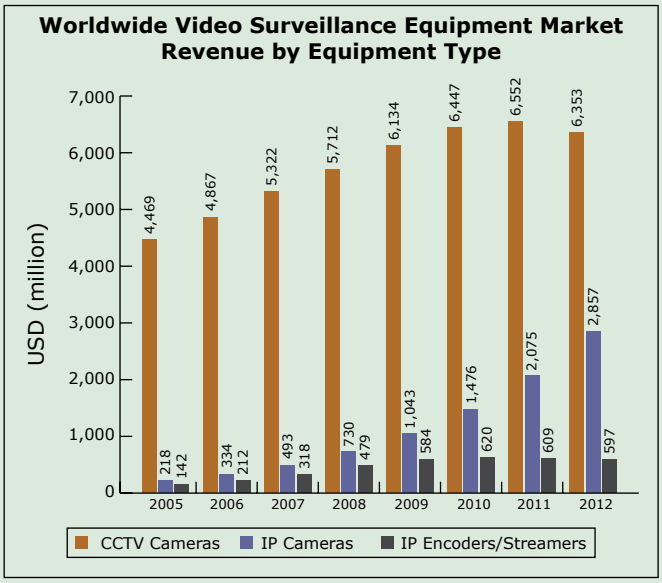
- Rising awareness in terms of security related to defense and counter-terrorism;
- Decreasing equipment and applications cost; and
- Better technology advances in hardware and systems.

DEMAND AND REVENUE TRENDS

Increasing global demand for video surveillance posted increasing revenue from worldwide video surveillance equipment at USD6.3 billion in 2005. Forecast revenue is USD12.7 billion in the year 2012, with Asia Pacific region accounting for almost a third of the market at USD3.59 billion.



Source: "IP/Networked Video Surveillance Market: Equipment, Technology and Semiconductors" by MultiMedia Intelligence, April 2008



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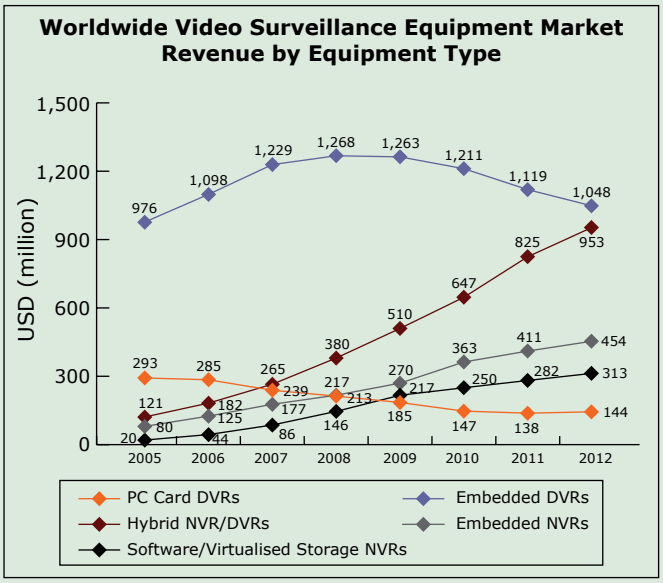

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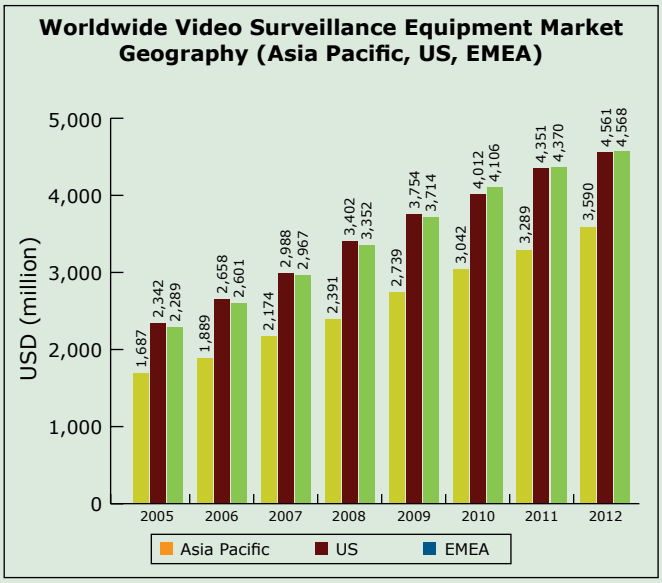


**EMEA = Europe, the Middle East and Africa*
Source: "IP/Networked Video Surveillance Market: Equipment, Technology and Semiconductors" by MultiMedia Intelligence, April 2008

According to MultiMedia Intelligence, the IP and Networked segment in the video surveillance industry will see a significant growth over the forecast period. However, the CCTV and analogue segment will continue to persist. It is estimated that 90% of surveillance video cameras in use today are analogue. Video chip vendors like Texas Instrument realise that most analogue CCTV camera companies need to build expertise on IP camera[3]. Though there will still be demand growth in the IP segment, the belief is that adoption of IP equipment may not be as fast due to[4]:

- Video surveillance integrators not skilled in network video or are not recommending it to users;
- Therefore, the change from physical security organisation to Information Technology organisation is expected to take time to happen;
- Legacy installations have long replacement cycles of five to ten years. IP installations thus need to wait for end-user cycle;
- IP products as premium products now do not appeal to as many mainstream buyers; and
- IP cameras performance parity is not yet the same as that for CCTV.

CUSTOMER SEGMENTS

The customer segments in the global video surveillance industry are diverse or fragmented in nature – government, retail, financial, industrial, transportation and education with significant overlapping. Each customer requires surveillance for different use, in turn involving different systems requirements and equipment according to the environment it operates in.

Customer and Use
Government - Public safety and facilities, Prisons and correctional facilities, Military Office buildings
Manufacturing plants - Communication infrastructure, Utility plants, Oil and gas plants, Mining areas
Retail - Shopping malls, Business centres and shops, Car park basements
Transportation - Airports, Train stations, Ports, Bus terminals
Financial - Banks, ATM machines
Education - Schools, University campuses, Car parks

Source: "IP/Networked Video Surveillance Market: Equipment, Technology and Semiconductors" by MultiMedia Intelligence, April 2008

INDUSTRY COMPETITORS

As the industry evolves, new competitors have emerged, for example, solution providers to the video surveillance industry. The industry has three types of competitors, that is, of legacy surveillance; digital and network-focus surveillance; and IT-oriented competitors.

Video Surveillance Industry and Market	Competitors of Video Surveillance Solution Providers		
	1. Legacy Surveillance Competitors	**2. Digital and Network-Focus Surveillance Competitors**	**3. IT-Oriented Competitors**

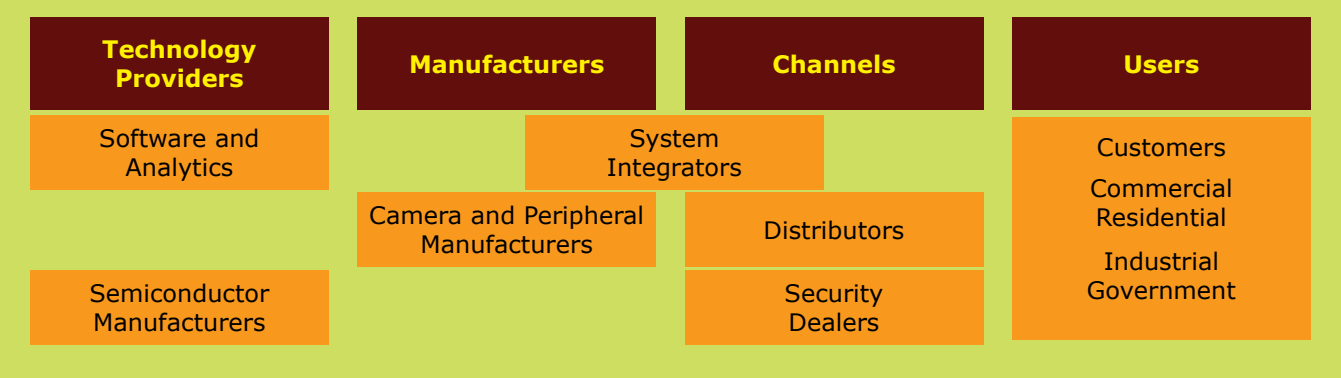
Source: "IP/Networked Video Surveillance Market: Equipment, Technology and Semiconductors" by MultiMedia Intelligence, April 2008

Legacy video surveillance solution providers like Honeywell, Bosch, General Electric and Panasonic still represent the biggest industry segment. On contrary, digital and networked-focus solution providers focus on digital and network technologies to steer their growth. They are the ones that take advantage of DVR and adding complementary networking technologies and video management software. Digital and network centric competitors are IndigoVision, Verint, March Networks and Steelbox

[3] *"Booming Video Surveillance Market Grabs the Limelight" by EE Times Asia, 4 April 2008*
[4] *MultiMedia Intelligence, April 2008*

Networks. IT-oriented video surveillance solution providers are usually companies with a history in IT. They differ from other competitors by diffusing and leveraging on IT relationships into their solutions. Among the highest profile IT-oriented competitors are Cisco, IBM, Intel, Oracle and Seagate. On top of segmentation by products, competitors and customers, the industry is represented by a chain of providers at almost every stage until the end users.

Video Surveillance Market Value Chain – Users to Technology Providers



Source: MultiMedia Intelligence

Two technology providers involved in the value chain are:

- Software and analytics providers responsible for the software that underlies the video surveillance equipment; supplying Video Management Software (VMS) and Video Content Analytics (VCA); and
- Semiconductor manufacturers offering innovation and technology for image sensors, video encoders and decoders, video codecs, memory for storage and processors, network and connectivity interfaces and analogue interface and power management.

Camera and peripheral manufacturers are the main producers of video surveillance hardware such as cameras, digital video recorders, displays and monitors, switchers, control room equipment, video streamers and encoders. Such manufacturers are world over, located particularly in China, Korea and Taiwan. Manufacturers may also be systems integrators who deploy video surveillance systems via a complex combination of hardware and software installations of video management software, viewing monitors, multiple cameras, video storage, cabling and control rooms. Distributors are crucial to the value chain and so are security dealers, who together recommend and advise end-users in the installation process. They also provide monitoring and response services including maintenance work.

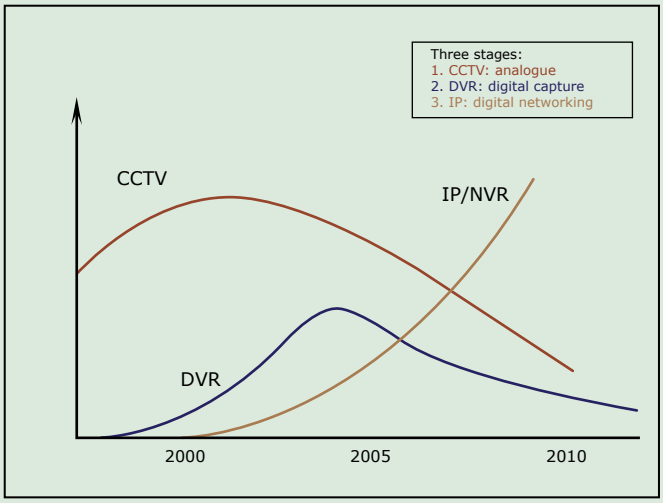
TRENDS IN VIDEO SURVEILLANCE TECHNOLOGY AND SYSTEMS

VIDEO SURVEILANCE SYSTEM ARCHITECTURE

The architecture of video surveillance system has improved over the years due to factors such as convergence of technologies in securities and IT functions, merging of computers and CCTV and other technologies replacing conventional system[5]. General trends indicate that over the years there is a shift in the technology used from analogue-based to digital and lately, to IP or network-based.

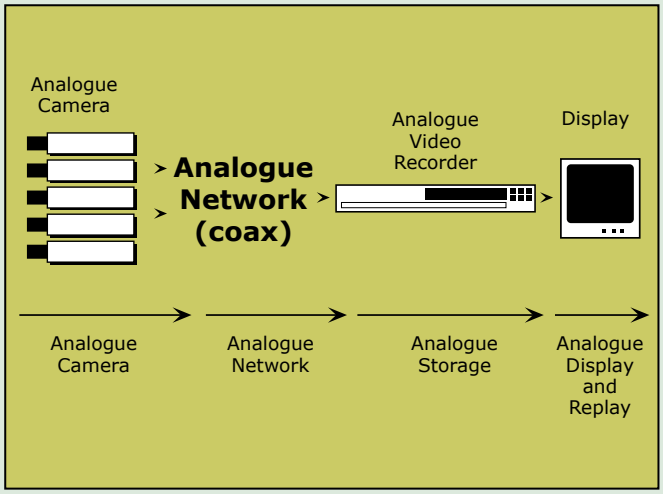
Today, analogue cameras and CCTV are no longer the only means to transmit and perform video surveillance. The surveillance system now comes in different types of model, each with different and specific functions for time of day, fixed or Pan, Tilt and Zoom (PTZ) capability, resolution quality, analogue or IP based and many other features providing necessary flexibility and use within the context in which they are engaged. Essentially, there are three types of video surveillance systems; analogue video system, digital video system and IP based video system.

In a typical CCTV system, analogue cameras are connected via coaxial cabling back to a central management room where the coax is connected to a monitor and a Video Cassette Recorder (VCR). This system initially used fixed bulky cameras with later adaptations that include a controller if the cameras have PTZ capability and is usually centrally located. All components therein are dedicated to this CCTV system and the system is 'closed' to any external access. Analogue systems have storage that is limited to low-technology tapes which are high in maintenance and limited in search capabilities. In contrast, digital technology offers more flexibility.



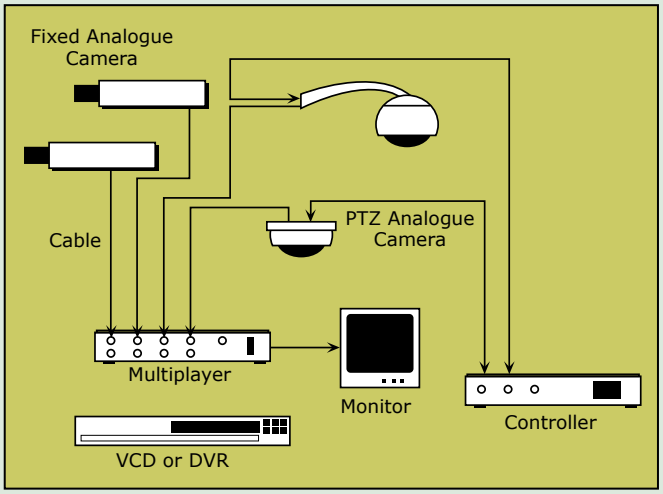
Source: IP CamSecure-Digital Surveillance Software, extracted from JP Freeman 2003 Report

Analogue Video Security System



Source: Adapted from Kane Computing Ltd-IP in action Live, 2005

Analogue Video Security System with Fixed and PTZ cameras

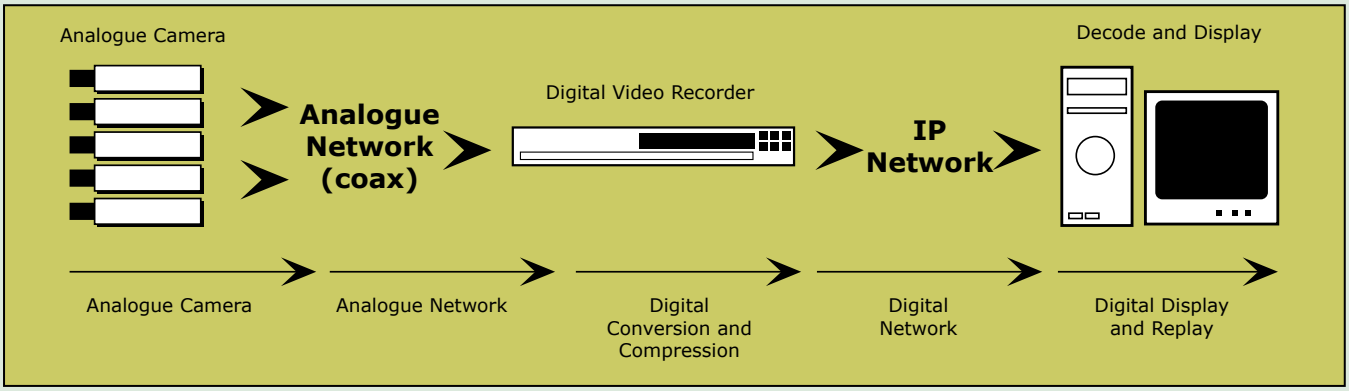


Source: Adapted from Transition Networks

Digital video surveillance systems use Digital Video Recorder (DVR) replacing the traditional VCR. Essentially storage is on a hard disk. DVR also offers computer connectivity, time/date, motion detection and easy searching due to digital images. Automatic adjustment to the cameras is also possible such as changes in colour, resolution, compression and capture speeds. Such flexibility saves cost and time on search and retrieve functionality.

[5] *"Surveillance & Security Market Trend" by JP Freeman, 2003 Report*

Shift from Analogue to Digital Infrastructure



Source: Adapted from Transition Networks

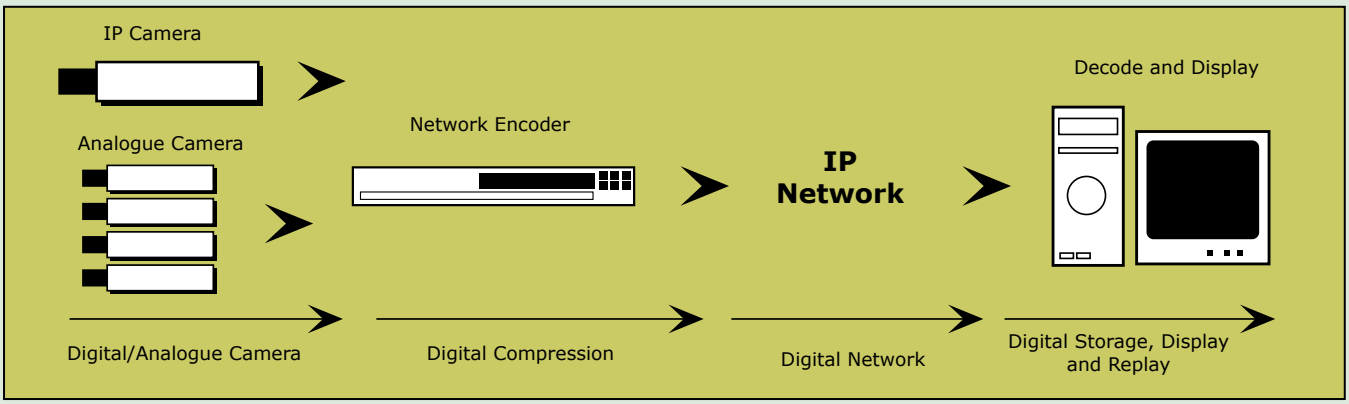
IP-based surveillance systems are relatively new to the market. Typical IP-based systems use cameras over a Local Area Network (LAN) to any PC or server on the network. Since the cameras are IP addressable, they can be effectively accessed from anywhere in the world. IP-based video surveillance also offers advantages in scalability, cost and technology. Analogue systems are limited to maximum of 32 cameras. IP system scalability allows for as little as three or more than 300 cameras on a server at any one point of time.

Advantages of IP surveillance system over DVR systems with analogue cameras include:

- Lower installation costs, as IP eliminates the need for dedicated video cabling;
- As system has IP standards, cameras are easy to connect and offer remote access;
- Integrates with existing CCTV systems and equipment;
- Smarter network cameras take on much of the work of the DVR and include functions of time scheduling, targeting higher frame rates, motion detection triggering and more;
- Highly scalable solutions, with no maximum number of cameras; and
- Remote accessibility and storage mean IP network video is more reliable and secure.

Beyond security, applications such as process control, integration with databases and employee training can provide cost savings.

Evolution from Digital to IP-based Networks and Cameras



Source: Adapted from Transition Networks

Issues going forward for surveillance systems are:

- Standards development to identify 'protected' bandwidth requirements on shared networks[6], on installation, liability cost and specific cable colouring;
- Digital storage capacity increase to provide a robust platform allowing user to benefit fully from digitalisation. Also for network video cameras to allow interoperable plug-and-play communication standards between camera and storage devices; and
- Fiber-based backbones with Power-Over-Ethernet (POE) connectivity for surveillance system.

[6] *GovtSecurity.com*

TYPES OF CAMERAS

Cameras used in surveillance today offer different conditions and purposes of usage depending on requirements necessary.

Type	Function
Indoor Camera 	Indoor camera is used for indoor security mechanism. Depending upon your security needs, you can mount it at any suitable location inside the building. Suitable for security in location where indoor surveillance is required for example, homes, schools, offices, and hotels.
Outdoor Camera 	Outdoor CCTV camera is used for the outdoor such as entry and exit points with limited night lighting. Outdoor cameras typically have hard shell vandal-proof casings and a variety of lens options.
IR Day/Night Camera 	This type of camera is used for high alert security areas for day and night surveillance. In the daytime, the camera functions like a normal camera with standard colours but at night, it switches to 'low-lux' black and white mode. When visibility decreases due to no-light situation, Infrared LEDs automatically kick in. These cameras are also used by military personnel and in parking lots.
Dome Camera 	Dome cameras are installed inside a dark dome offering compact design for a discreet appearance. These cameras can also be rotated and tilted manually. Dome type cameras are used in public places like railway stations, bus terminals, and other areas where there are huge gatherings of people.
Bullet Camera 	Bullet cameras encased in bullet shaped housing are used in residential places as well as commercial places. They are small in size, with integrated design and offer illuminate viewing even in darkness and are weatherproof.
Vandal Proof Camera 	Vandal proof cameras are for outdoor security. These cameras are sheltered within solid material and are covered by a break-proof glass. These cameras are difficult to break making them suitable for high security. They are suitable for wall or ceiling mounting and are rain and fog resistant.
Hidden Camera 	Hidden cameras are compact in size and are used for secret monitoring. They are usually installed in public places like department stores, theatres, and clubs. Hidden cameras have a built-in recorder that records and broadcasts simultaneously. By using a number of security cameras in network, strategic surveillance is obtained.
Pan Tilt Zoom Camera 	Pan-tilt-zoom camera offers the ability to view and zoom in all directions. One can even set the camera to automatically rotate to different fields of vision.

Source: Axis, Canon, CCTV today and various websites

VIDEO COMPRESSION STANDARDS

Without video or data compression, the efficiency of the video storage system is compromised. Different applications have different concern on clarity of image, data volumes and compression format. Selection of compression standards depends on the network and application used. In general, the less the compression the better the playback and recorded image will be.

Commonly Used Standards	MJPEG	MPEG2	MPEG4	H.264
Bandwidth and Storage Required	High	High	High	Low
Requirements of bit rates for high quality	Highest	High	Low	Lowest
Court Usage (as evidence)	Yes	No	No	No

Source: Adapted from Axis Communication, Kance Computing Ltd-IP in action 2005 and various websites

TRANSMISSION OPTIONS

Coaxial cable is the standard for video transmission for years[7]. Today, many security professionals find the quality, bandwidth and distance required for basic surveillance sometimes go beyond coaxial cable.

The choice of transmission for video surveillance depends on location of cameras and controls. The transmission system has to reproduce the signal accurately at the receiving end point with no loss of information whichever the system. There are two main types of connections for video surveillance; wired and wireless.

Wired – Coaxial Cable

Coaxial cable consists of a conductor, usually a bare copper surrounded by a polyethylene dielectric. Coax is shielded with a metal to protect against Electromagnetic Interference (EMI). Coax's low attenuation and resistance to EMI makes it an excellent choice for transmission distances as long as it is within 1,500 feet. Performance is normally measured in high frequency loss per 100 metres - the lower the loss the less the distortion to video signal. Therefore, higher quality cables are used when transmitting the signal over long distances.

Coaxial cable is a widely used technology that works well and cost effective. Because it does not require signal conversion, it has fewer connection points that could lead to signal loss or breakdown. This axial cable or the newer version cable called Unshielded Twisted Pair (UTP) is widely used indoors and places where distances are not that far.

Wired – Fibre Optic

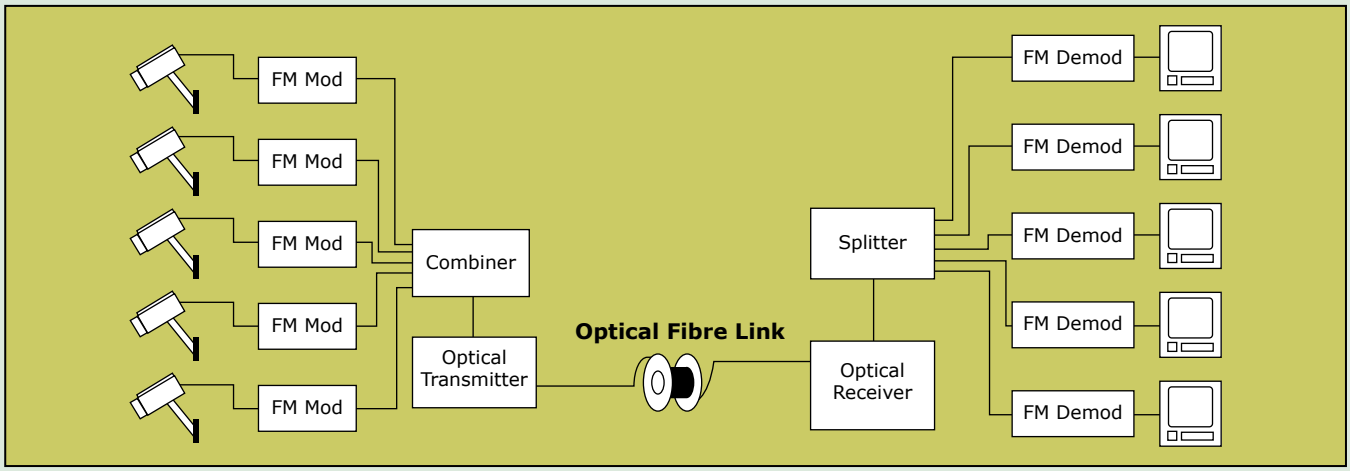
Fibre optics transmission is the next most popular means in transmitting video, audio and various signals. It carries more information and delivers with greater reliability than coaxial cable as the medium of transmission is light. Light waves have an extremely high frequency and travel at 186,000 miles (300,000km) per second.

In addition, the use of fibre optic cable will allow for cable to be installed in over 1,500 metres on multimode and distances of over 10km on a single mode cable[8]. If a usual fibre optic attenuation is between 0.3 and the decibel per km is 3dB/km, that fibre optic links can achieve distances over 60km. Fibre optics also present unique benefits not present in either coax or UTP cabling such as:

- Smaller size and better in strength, so easier to install pulling through conduit or in overhead trays;
- Immune to electrical interference such as EMI, RFI, high voltages that distorts picture and audio;
- Offers higher bandwidth, with more improved on reliability and overall transmission performance ;
- Does not corrode or affected by most chemicals; and
- High degree of security – The signal content is difficult for unauthorised tap or access.

[7] *CommScope White Paper, May 2008*
[8] *www.transition.com*

Diagrammatic View of Typical Multimode Transmission using Fibre Optic



Source: Adapted from www.cctv-information.com

The cost of fibre optical installation can be high, but many city councils and government use it because of the unique capabilities. Usually, if cost is not an issue, fibre optic is the perfect video surveillance medium especially for those over long distances.

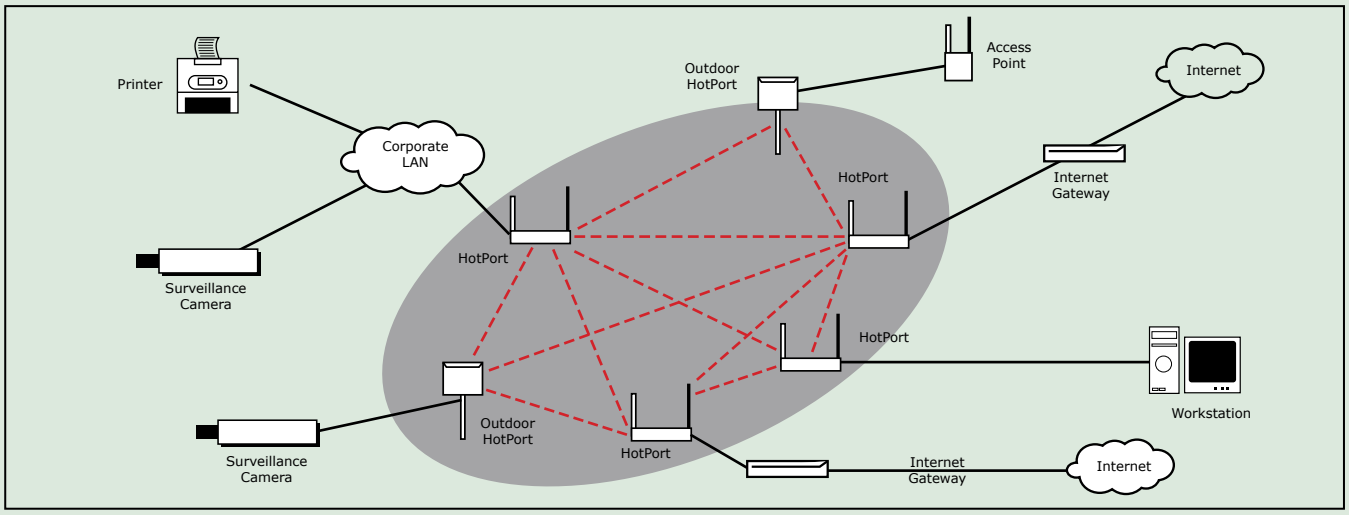
Wireless Transmission – Mesh Network

Wireless network uses radio waves to transmit and receive data. Most wireless surveillance connections use the 2.4GHz frequencies to transmit video images. In US, the Federal Communications Commission (FCC) has reserved the 4.9GHz spectrum for public safety agencies to conduct video surveillance. There are many types of wireless network but the most significant enabler for the video surveillance market is the deployment of wireless Mesh network.

Mesh network topology extends the range of traditional LANs and WLANs. It can effectively, wirelessly and easily connect cameras with mesh nodes that are small transmitters and use the common Wi-Fi standards of 802.11a, b and g. Unlike other fixed wireless connections, mesh only needs one node to be physically wired to a network connection like DSL Internet modem. The biggest advantage of this network is self-configuring and self-healing, where all the nodes can automatically incorporate a new node into the existing network and find the fastest and most reliable path to send data.

Using video senders and receivers, a Pan Tilt Zoom camera can be controlled from anywhere in the world with less than a second delay over low bandwidth circuits. Wireless transmission negates the need for high cost leased line and Integrated Services Digital Network (ISDN) circuits by converting the analogue video signal to MPEG4 streams, which can be transmitted across cost effective Internet or wireless networking.

Wireless Transmission – Mesh Network



Source: Adapted from County Communication

[9] *Cisco, meraki.com, hindawi.com*

Wireless Transmission - Infrared Beams

With this type of system, the video is superimposed onto an infrared beam by a transmitter. The beam is then aligned to a receiver, where the signal is produced as a conventional video signal. There is a range of beam power but there is always a trade off between range and the quality of transmission. Usually if high resolution and high penetration are required, then the range covered drops dramatically to a shorter distance. Examples of trade off between ranges in metres with video requirement are as follows:

Requirement	Model A	Model B	Model C	Model D	Model E
(1) Economic quality	190	710	1,220	2,350	3,100
(2) Full quality	120	320	620	1,200	2,100
(3) High Penetration	30	160	300	750	1,200
(4) High Resolution	80	250	390	950	1,820
(3) and (4) together	-	120	250	600	900

Infrared links offer cost-effective solution to free space transmission. However, performance can be affected by weather and environmental conditions. It is also suitable for very short local transmission. There is no requirement of any license to perform an infrared link.

Wireless Transmission - Microwave Links

This link is flexible, reliable and uses very high bandwidth. Microwave links carry the video and telemetry along a link from a transmitter to a receiver where distance ranges from one kilometre to 50 kilometres[10]. They are more expensive than infrared links and not affected by weather conditions as much as infrared links. There is no signal encryption which is generally necessary to guard against unauthorised access by the third party since the beam is so direct. The signals however, should be mounted at higher position and the range between transmitters to a receiver must be in line on sight.

Case Study: Penang City Council (Majlis Perbandaran Pulau Pinang – MPPP)

Penang is the first state in ASEAN region to use wireless broadband in their Close Circuit Television (CCTV) system. The system uses wireless bandwidth with capacity of 4.9 gigahertz (GHz) for overall 31 locations through out the whole state. The system, which is named as Penang Integrated Public Safety (PIPS), will have the ability to act as an alert system and for public announcement in addition to its audio system.

Source: "Pulau Pinang Pertama Guna CCTV Jalur Lebar" by Utusan Malaysia, 6 November 2007

STORAGE

Storage solutions depend on a PC or server ability to store data. For decades, images were stored in video cassettes. Today, with the rapid advancement in technology of video surveillance system, video is stored in hard disks - as larger hard drives now cost lower, it is now becoming less expensive to store video this way. Two traditional approaches to hard disk storage are storage attached to the actual server running the application, called direct attached storage; and the other with storage separate from the running application, called Network-Attached Storage (NAS) or a Storage Area Network, commonly known as SANs.

As video surveillance moves toward network-based systems, end users can specify their needs for higher resolution cameras and longer retention times. This leads to the need for even greater storage capacity in video surveillance systems. IMS Research forecasts[11] a total of 3.3 exabytes[12] is needed to store video in a new video surveillance system. IP Storage Area Networks (IP SANs) offered improved scalability, storage capacity, reliability and retention. As the processing system is no longer carried out by DVRs, fewer DVRs or NVRs are required to manage the same number of cameras and store the image.

It has been said that external storage like SANs will likely to be the next step forward in the evolution of video surveillance storage.

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[10] *According to www.cctv-information.com*
[11] *'World Market For External Storage Used For Video Surveillance, 2008'*
[12] *An exabyte is a unit of computer memory equal to 1,024 petabytes. One Petabyte is equal to 1,000 terabytes*

LEVEL OF HUMAN INTERVENTION

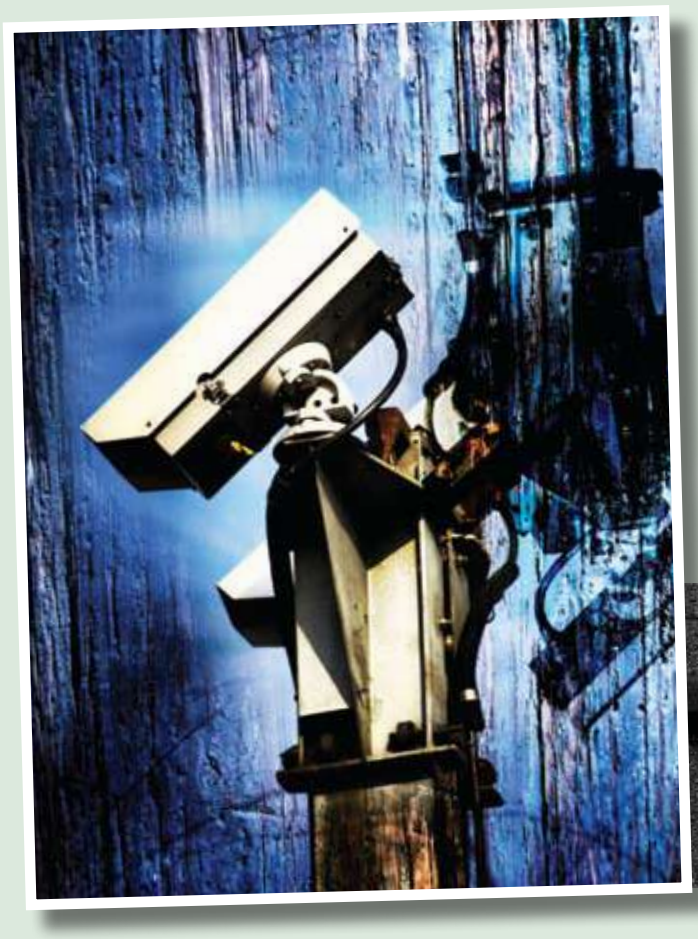
Although the need for human intervention in carrying out surveillance tasks lessens due to technology advances in video surveillance, there is still a need in the minimum level of human intervention in terms of monitoring. This is due to the human capability to be able to make subjective decision and respond appropriately compared to a video surveillance camera. For example, say in a shopping centre a person is running unusually. The video surveillance system through video content analytics software can detect that the person is running but it may not be able to differentiate between a benign event or a criminal event.

However, with the digitisation that is taking place in video surveillance systems, the function of complex analysis in surveillance and monitoring can be assisted. With the advent of video content analytics, the job of video surveillance can almost take care of itself and suspicious images and recordings can be extracted quickly without the tedious need for security personnel to continuously monitor or plow through video recordings that will take immense of time and resources. Video content analytics usually provide the following[13]:

• Motion tracking	• People counting
• Create virtual fence	• Queue management
• Prohibited area detection	• Fire and smoke detection
• Left item detection	• Behavior recognition and face recognition

For example, in a real test scenario of a behavioural recognition system monitoring access to parked aircraft in the US, the system will be pre-programmed to detect and track unfamiliar movements or further to that, programme the area as a prohibited space.

Any unusual movements or sights will be alerted by the system. Using this, the need for human intervention is still required but in a smaller team of which the operating cost would be reduced from 720 man hours to 2.5 man hours of labour. So, instead of employing staff 24/7 for 30 days to monitor the tunnel, only two and a half man hours are required over a 30-day period[14].



[13] *"IP/Networked Video Surveillance Market: Equipment, Technology and Semiconductors" by MultiMedia Intelligence, April 2008.*
[14] *White paper on "Video Content Analysis, what is it and why would I want it?"*

VIDEO SURVEILLANCE IN PUBLIC SPACES

Of late, there has been a worldwide acceleration in the deployment of video surveillance especially in the public realm. So much so that the practice of installing video surveillance cameras in public spaces has become a norm. The increasing trend of urbanisation, worldwide terrorism and the need for public safety due to escalating crime have shifted the terrain in worldwide government spending on security and surveillance. Due to this demand push, there has been a consistent overall trend of spending by local government authorities across countries to deploy public video surveillance in public spaces.

DEFINING PUBLIC SPACE

A public space is defined as any place that an individual has the right to access and use as opposed to private space which may have restrictions. In Australia, a public place is defined in the Local Government Act 1993 as public reserves, public baths or swimming pools, public roads, public bridges, public road-ferries with the addition of public transport and car parks.

In Europe, a public area is defined as a place which can be in principle accessed by anyone freely, indiscriminately, at any time and under any circumstances. Public areas are open to the public. Examples of relevant public areas include public parks, pedestrian streets in the city centres, outdoor public parking areas, residential neighborhood streets and areas such as sports arenas and subway stations[15].

PURPOSE OF VIDEO SURVEILLANCE IN PUBLIC SPACES

Purpose of Video Surveillance in Public Spaces is "Security" in Various Aspects such as:
1. Prevention of any potential trouble - Providing assurance or safe feeling on a street or any public area. Covert surveillance can avoid crime such as kidnapping and snatch thief.
2. Promotion of security – Allows for reducing the fear of crime amongst individuals.
3. Crime detection - To help authorities curb crime. A proposed hidden camera is essential as crimes may be occurring in other places apart from where the unhidden systems are fixed. Also a video taken with desired picture quality is important for identification of suspects on investigation.
4. Protecting public and private properties - Video surveillance is provided as a facility of safety for people to gain easy assistance in an emergency.
5. Maintenance of city centres - To assist local authorities in monitoring city centres in terms of managing cleanliness and monitoring the upkeep of surrounding areas.
6. To be used in court of law – Provision of images admissible in court of Law as evidence.
7. Traffic management – To aid traffic management, accident or problems on the highway.

STRENGTHS AND WEAKNESSES OF VIDEO SURVEILLANCE IN PUBLIC SPACES

Though the implementation of video surveillance in public spaces has its own strengths, however, findings have shown that there are some pitfalls and weaknesses as well:

Strengths	Weaknesses
Video surveillance can reduce the fear of crime and increase the perception of safety	Video surveillance can increase level of expectation in the community that may not be manageable or sustainable
Image identification is easier in small populated area	Image identification is difficult in a big populated area
Video surveillance recordings and images can be used for prosecutions in court	Offenders use face caps, balaclavas and sunglasses to disguise their identity
Early detection of crime could offset the cost of installation	Installation and maintenance could be very expensive depending on the area and density
Installation could lead to more crime detection and arrest	Installation of video surveillance cameras at a particular area only may lead crime occurrence in other places
May lead to reduction in crime	There is a possibility that criminals and community become immune to the existence of the camera

[15] *"European Commission for Democracy Through Law (Venice Commission) opinion on Video Surveillance in Public Places" by Public Authorities and the Protection of Human Rights*

Strengths And Weaknesses Of Video Surveillance In Public Spaces (Continued)

Strengths	Weaknesses
Is most effective with mix of crime prevention strategies such as alarm and police patrol	Less effective if used as a stand alone
Is more effective if monitored by skilled operator	Places a sense of responsibility in the hand of skilled operator creating high expectation from the individuals in that area as to enhancement to their personal safety
The advancement in video surveillance technology i.e. hardware and software are constantly advancing and reducing with costs	Issues on incompatibility with latest video surveillance
	Technology can breakdown, needs repair, and runs out of older version spare parts.
Future technology should include face recognition, alerting suspicious activity and also 3D images	Limitation as to without the voice recognition system would not allow for operators to sense threatening or intimidating language

Source: Adapted from "To CCTV or Not to CCTV – That is the Question: But is it the Answer?" A Practitioner's Point of View, August 2003

SUITABLE VIDEO SURVEILLANCE SYSTEMS IN PUBLIC SPACES ENVIRONMENT

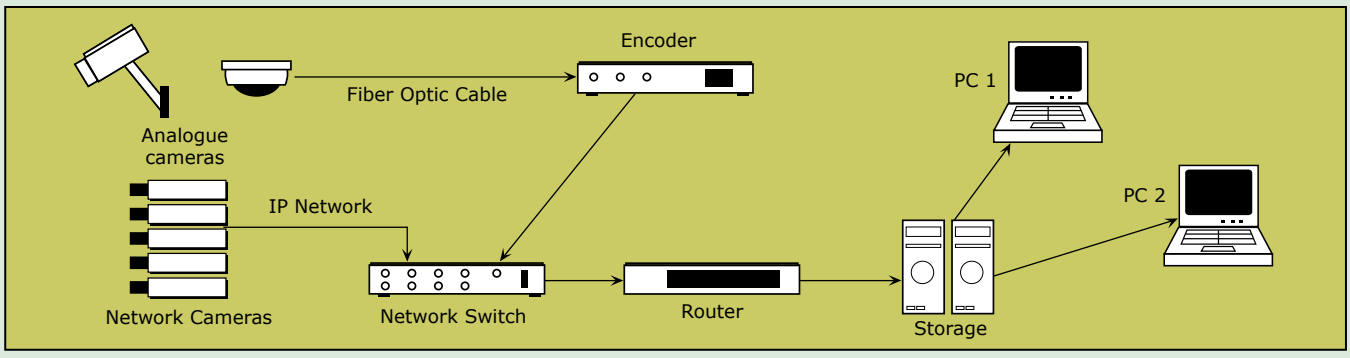
Public spaces involve great scale of area covered. Therefore, a surveillance system needs to suit the given environment for cost-effectiveness and achieve specific requirements. The type of area, what image to be captured – either people or traffic, and its operations are elements that need planning and careful selection. Main criteria are aspects on spectrum, video compression, transmission, cameras and storage.

Criteria for Public Spaces' Video Surveillance based on Commonly Used and Effectiveness

Spectrum	2.4GHz is one of the most widely used unlicensed bands for public areas but the 4.9G is licensed to public safety agencies, usually the police.
Video Compression	MPEG-4 , MJPEG and ITU standards of H.264
Transmission	Hybrid Network – Fibre Optics and Internet Connection – is the most talked about technology, hailed as the best media conversion system
Cameras	PTZ with Infrared and vandal proof casing with real time zooming up to 300 metres
Storage	IP SANs which have capacity of more than 1,000 terabytes.

Source: Adapted from various sources

Hybrid Video Surveillance System, with Media Conversion



Source: Adapted from various sources

COST OF VIDEO SURVEILLANCE IN PUBLIC SPACES

Determining factors of cost on the type of video surveillance installed are firstly, who and what is being monitored. The objective is to find the "right" system to suit customer and area specific needs. Costs include initial funding and maintenance. As there is no fixed rate, it all depends on type of camera, infrastructure and system required for the customer and location.

In a simple ballpark calculation, the UK example for placing a video surveillance system costs RM12,500 per camera. This is higher that the ballpark for Malaysia at RM9,701 per camera.

Estimated cost for deploying video surveillance in public spaces in UK and Malaysia

UK

Example 1 Capital cost:	
Number of Cameras	162
Infrastructure	£2 million for 10 years
Running cost – CCTV system maintenance	£688 per camera a year
Cost per camera per year (based on capital + one year running cost)	**RM12,500***

**Assuming exchange rate at RM6.80 per sterling pound*
Source: Cambridge City Council, CCTV System, March 2007

Example 2 Capital cost:	
Number of Cameras	10,524 in 32 London boroughs
Infrastructure	£200 million for 10 years
Running cost	Not stated

Note: This may be inclusive of running cost
Source :www.thisislondon.co.uk/news, September 2007

Malaysia

Capital cost:	
Number of Cameras	162
Camera System	RM1,863,000
Wireless Equipment	RM2,361,960
Other Items and Accessories	RM2,297,970
Control Room Equipment:	
-Software	RM177,300
-Work Station	RM79,000
-Server and Video Recorder	RM610,000
Others	RM 1,451,400
TOTAL	**RM8,840,630**
Cost per camera (based on capital + one year running cost)	**RM9,701**
Running Cost:	
Maintenance Costs :	
Year 1 Comprehensive Maintenance, includes spare parts and labour	RM 480,000
Year 2 Comprehensive Maintenance, includes spare parts and labour	RM520,000
Year 3 Preventive Maintenance, excludes spare parts	RM300,000
Year 4 Preventive Maintenance, excludes spare parts	RM 375,000
Year 5 Preventive Maintenance, excludes spare parts	RM 470,000
Year 6 Preventive Maintenance, excludes spare parts	RM 580,000
Year 7 Preventive Maintenance, excludes spare parts	RM 725,000
Year 8 Preventive Maintenance, excludes spare parts	RM 900,000
Year 9 Preventive Maintenance, excludes spare parts	RM 1,125,000
Year 10 Preventive Maintenance, excludes spare parts	RM 1,400,000

Source: Quoted by Prisma Bytes Sdn.Bhd

Malaysia

It has been estimated by the Ministry of Housing and Local Government, Malaysia, that the cost of installation of 65 CCTV cameras within the vicinity of Putrajaya may cost within RM3 to RM4 million. These cameras are basically meant for preventive and corrective action.

Source: Perbadanan Putrajaya

UK

As at February 2007, there are about five million CCTV cameras installed throughout UK. With installation and running cost, cameras would approximately cost at least £3,000 per camera. On the other hand, the equipment supply industry is worth more than £1 billion annually.

Source: Times Higher Education Press, UK, February 2007

COMPARISONS: OTHER COUNTRIES' PUBLIC VIDEO SURVEILLANCE

Countries like the UK are the forerunner in the use of public video surveillance as a primary tool to monitor public activities and prevent terrorism. A substantial amount of money has been spent by the UK Government on new technology, making it the country with the most security cameras than any other countries in Europe. Overall, the growing prevalence, in the use of such surveillance systems in diverse applications is gradually being felt by society at large.

The US and other European countries however did not respond as fast in the use of public surveillance. City surveillance is not growing as rapidly as initially expected due to privacy reasons[16]. But in keeping up with other countries, US of late has followed suit in fully utilising the system after realising that it may just be the powerful tool that they need to combat terrorism.

In Asia, countries like China are not only the major producers of video surveillance equipment in the world but also one of the largest to deploy video surveillance systems across their cities. With major events like the 2008 Beijing Olympics bringing millions of tourists to the country, security and surveillance have become a priority to the country.

UNITED KINGDOM

The UK relies heavily and extensively on video surveillance as a tool to fight crime. This is evident from the development of public video surveillance in the country. The provision of CCTV in public spaces in UK started in the early 1980s. Though UK has about one percent of the world's population, the number of CCTV cameras used is equivalent to one of every 14 people. Overall, there are an estimated 4.2 million cameras[17] in the country. Londoners being the most densely monitored society boast about 500,000 cameras with the average Londoner appearing on public video surveillance up to 300 times on any given day[18] making the city a "Maximum Surveillance Society".

Due to the huge investment involved in the implementation of public CCTV surveillance, the local authorities or borough councils are usually the owners of the CCTV systems. Today, the CCTV is the best crime prevention method funded by the UK Government. According to the Public Sector Technology and Management website, the CCTV market in the UK is expected to be worth £700 million annually.

Year	UK Public Video Surveillance Developments
1985	The first large-scale public surveillance systems in Bournemouth, UK
1996-1998	CCTVs account for more than three-quarters of the Home Office's spending on crime prevention
1997	CCTV systems operational in over 300 towns and city centres in UK and Wales for purposes of preventing and detecting crime, protecting public properties, managing city centres and monitoring traffic
1999-2003	The UK Home Office in a Crime Reduction Programme undertook major investment in public space CCTV surveillance and made available £170 million in capital funding to the local authorities through a bidding process resulting in more than 680 CCTV programmes installed in town centres and other public spaces
2007	UK Government spent a total of £200 million on 10,000 crime-fighting cameras in London[19] alone. In April, the UK Home Office announced new CCTV systems that are armed with speakers to warn offenders are in the planning. Its trial phase indicates that the new "talking cameras are a success". To continue efforts in development of the operation of public CCTVs and to set the way forward clearly and concisely in terms of standards, enforcement and management of CCTVs, the Home Office drafted a National CCTV Strategy in October 2007

Source: Various sources

In the UK, regulations require that all CCTVs that process data are registered with the Information Commissioner, which is an independent body to promote access to office information and protect personal information. Other legislations regulating the installation and use of CCTV systems in public places include the Data Protection Act 1998 and the Human Rights Act 1998.

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[16] *Products Sectors and Challenges in US Market Segments, 6 June 2007*
[17] *"Britain is surveillance society" by BBC News, 2 November 2006*
[18] *"The Maximum Surveillance Society: The Rise of CCTV" by Clive Norris, Gary Armstrong, September 1999*
[19] *Billions spent on CCTV have failed to cut crime and let to an "utter fiasco", says Scotland Yard surveillance chief, http://www.dailymail.co.uk*

UNITED STATES

While public video surveillance is not a recent phenomenon in the US, the exponential growth in its use is not as fast as in the UK. Early public CCTV surveillance lacked capital funding and local public support and the systems generally consist of cameras installed in downtown business districts or in shopping areas. Although large public or city wide CCTV systems are rare in the US, the scope of use for the systems is mainly for monitoring traffic on the city streets and interstate belt lines around the city, subway corridors and mass transit routes for vandalism, burglary areas such as city parks and drug dealings in public housing and high crime areas[20].

Lately, in the wake of serious events of terrorist attacks and bombings, the overall American public began pressing for tighter security measures. This has made the public CCTV surveillance in and around US cities more acceptable to the American society boosting the industry's growth. More recently, millions of dollars were channeled by the Department of Homeland Security to local governments nationwide for the purchase of high-tech video camera networks to accelerate the plan of a "surveillance society".

Year	US Public Video Surveillance Developments
Early 1960s	The used of CCTV surveillance in banks was mandated by federal laws followed by the use in commercial buildings.
1966 and 1971	The earliest documentation of public CCTV surveillances instances was in 1966 in the city of Hoboken, New Jersey and 1971 in Mount Vernon, New York[21]. Both surveillance systems were enforced by the American Police Department which was implemented in small scale with fewer than half a dozen of cameras covering each city. Due to the minimal impact on crime in each of the city, the systems were dismantled after 3 years of installation.
Mid 1980s	Other cities like Newark, New Jersey, Charleston, West Virginia and Miami Beach, Florida also began experimenting with small numbers of cameras.
2003	The Department of Homeland Security has handed out some USD23 billion in federal grants to local government for surveillance equipment and training.
2004	Chicago unveil plans to have more than 2,000 surveillance cameras in public places which are in network that would use sophisticated software to spot emergencies or suspicious behavior. In place 2006, the USD5.1 million cost will be covered through a federal homeland security grant[22].
2005	New York City officials added surveillance plans to include 1,000 video cameras and 300 motion detectors for subway, commuter railroads, bridges, tunnels and hubs; USD212 million allocated on the systems with each camera costing about USD1,200.00 and covering 300 feet[23].
2008	New York City police to install more than 100 cameras in Lower Manhattan by 2008 as a part of a proposed USD90 million surveillance system that also links 3,000 public and private cameras into a central command hub. The new cameras will bring the total downtown to about 7,000.

Source: Various sources

The US Congress in 1968 passed the first major electronic surveillance law, Title III of the Omnibus Crime Control and Safe Streets Act 1968. The Act defined the use of electronic surveillance; however, Title III did not specifically address video surveillance. Twenty years later, the Electronic Communications Privacy Act was passed by the Congress in 1986. This Act allowed law enforcement to use rapidly expanding technologies such as video surveillance. The application of the Act can be witnessed in the World Trade Centre bombing in 2001 when the Federal Bureau of Investigation (FBI) was allowed to conduct extensive video surveillance at a defendant's home to collect evidence used to convict him.

In 2004, the Congress passed the anti-video voyeurism legislation which prohibits knowingly videotaping, photographing, filming, recording by any means, or broadcasting an image of a private area of a person without that individual's consent, under circumstances in which the person has a reasonable expectation of privacy[24].

AUSTRALIA

The use of video surveillance at public spaces in Australia is expanding. The first system was implemented in early 1990s and was installed and overseen by the local government authority. The push for the establishment of CCTV systems comes from the local government itself including the source of funding.

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[20] *"Public CCTV Surveillance Systems: A Review of the Issues" 22 May 1996*
[21] *"Public Video Surveillance: Is it an Effective Crime Prevention Tool?" by California Research Bureau, June 1997*
[22] *"Chicago Mayor Unveils Surveillance Plans" by NewsMax Wires, 10 September 2004*
[23] *"New York City to add CCTV Cameras to Subway" by Privacy International, 24 August 2005*
[24] *"Video Surveillance – Surveillance Camera, PHR2006-Privacy Topics – Video Surveillance" by Privacy International, December 2007, www.privacyinternational.org*

Year	Australia Public Video Surveillance Developments
1991	Perth was the first city in Australia to administer a public video surveillance system. Operation of the system or open-street CCTV as it is known in Australia costed AUS750,000 with 48 pan-tilt-zoom monochrome cameras.
2002	Perth has largest town centre surveillance systems in Australia, with 105 cameras[25]. The number of local government with CCTV systems grew to 33 with 20 out of the 33 systems solely funded by them.
2005	The number of local governments with CCTV systems doubled to 66 from 33 in 2002. The New South Wales Government reported the existence of 7,000 cameras in Sydney alone[26].
2007	In 2007, the Australian Security Industry Association estimated that there were between 40,000 and 60,000 cameras permanently monitoring Sydney.

Source: Various sources

In 2002, it was reported in the study of Open-Street CCTV in Australia that there is no specific Federal, State or Territory legislation covering CCTV surveillance in public areas. However, the study showed findings that in 2000, the Labour opposition introduced a bill into the ACT Legislative Assembly. The Surveillance Camera (Privacy) Bill 2000 would have represented the first statutory regulation of overt video surveillance in Australia. The bill however, failed to pass into law. Contrary to that, in the same year the New South Wales Government introduced a guideline for the adoption of CCTVs.

The guidelines known as the NSW Government Policy Statement and Guidelines for the Establishment and Implementation of Closed Circuit Television (CCTV) in Public Places provided a policy framework and fundamental principles assisting agencies considering CCTV as a safety measure. The guidelines also incorporated issues on privacy and liability to be considered as well as information such as the Code of Practices, Protocols and Standard Operating Procedures for operating the schemes. It also stipulates the need for local councils to refer to the Privacy and Personal Information Protection Act 1998 when considering the establishment and implementation of CCTV. Additionally, when CCTV systems are installed in public areas where recordings of local council employees such as street cleaners and garbage collectors are made indirectly, the Workplace Video Surveillance Act 1998 applies.

CHINA

In China, the Golden Shield project started in 1998 by the Ministry of Public Security and resumed operations in November 2003 was the catalyst to the widespread deployment plan of video surveillance. One of the stated objectives of the Golden Shield project is the establishment of a nationwide network of closed-circuit television or CCTV cameras in public spaces to improve police response times to outbreaks of social unrest. When implemented, the Chinese citizens will be observed around the clock through networked CCTV cameras and remote monitoring of computers. In Beijing itself, there are 260,000 image-gathering tool. The roll-out of the Golden Shield project is already underway.

Year	China Public Video Surveillance Developments
2003	The Golden Shield project commenced operation.
2006	The Chinese Government mandated all Internet cafes, restaurants and other entertainment venues to be installed with video cameras that lead directly to the local police stations[27].
2007	The Economic Observer Online reported that by end of 2007, 3,000 ATMs, most markets, gas stations and small and medium-sized schools will be part of a network monitored by police. The city management and law-enforcement agencies to extend reach to all busy streets, bridges and tunnels.
2009	The Chinese internal-security market reported to be worth $33 billion by 2009[28].
2010	In its efforts to create a "safeguard society", the busy financial city of Shanghai plans to install 200,000 surveillance cameras by 2010 to deter crime; to cover 600 square kilometers, that is approximately 300 cameras per square kilometer.

Source: Various sources

In terms of legislation, according to a report by Privacy International, there are limited rights to privacy in the Chinese Constitution. Although there is a growing trend in the numbers of surveillance cameras installed in China, there are no laws regulating this system[29].

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[25] *"Open-Street CCTV in Australia: A Comparative Study of Establishment and Operation" by Adam Sutton and Dean Wilson, April 2003*
[26] *Caslon Analytics. www.caslon.com.au*
[27] *"Chinese's All-seeing Eye" by Naomi Klein, 29 May 2008*
[28] *"Chinese's All-seeing Eye: by Naomi Klein, 29 May 2008*
[29] *"Smile! You're on Communist Camera – Surveillance in China has gone high-tech, but people are starting to complain" by Globe and Mail, 23 June 2005*

PUBLIC VIDEO SURVEILLANCE IN MALAYSIA

The implementation of public video surveillance was first carried out in Malaysia in the 1990s. Generally, the growth in the use of public video surveillance in Malaysia did not begin in earnest until 2003. Currently, there are 113 areas in the Kuala Lumpur city installed with CCTV cameras which are being monitored by the police. Additionally, there are 255 CCTVs all over the city installed by the Integrated Transport Information System (ITIS).

Year	Malaysia Public Video Surveillance Developments
1966	The first implementation of CCTV systems in Malaysia was carried out by the Kuala Lumpur City Hall (DBKL) to monitor traffic in the city centre using black and white cameras connected with direct cables and leased lines. More cameras were added in phases, incurring a RM6.75 million spending on installation and another RM1.45 million on maintenance[30].
2003	A traffic monitoring system, commonly known as ITIS, was implemented within the larger area of Klang Valley. ITIS also provides vehicle detection and surveillance[31]. The Government issued a directive in March for all car park areas in public buildings to be installed with CCTV cameras. The directive also calls for all local authorities to stringently ensure that car park and building owners complied with the order.
2004	The number of CCTVs installed by DBKL amounted to 63; not only for traffic surveillance and enforcement but also flood monitoring, keeping an eye on snatch thefts, and public safety in major roads and locations in the city.
	The Cabinet issued a directive to all local authorities (Pihak Berkuasa Tempatan, PBT) to install CCTV in public areas to curb crime activities. All PBTs were given a 3-month time period to comply with the instruction which came into effect in July 2004.
	The Safe City Programme was initiated by the Ministry of Housing and Local Government for the installation of CCTV cameras as part of the 23 measures as stipulated in Strategy 2 of Target Hardening. The strategy states that the Ministry of Housing and Local Government (KPKT) will monitor the installation of CCTV in the cities and the Local Authority is required to report the status of implementation to the Ministry from time to time[32]. The Local Authorities are also required to refer to the Safe City Programme Minimum Technical Specification on Installation of Closed Circuit Television (CCTV) for implementation within their areas. The Internal Security Ministry reported the installation of CCTVs has proven effective within Kuala Lumpur, with 50% drop in snatch thefts, while the whole country saw a 26.2% drop[33]. It was agreed upon at the National Council for Local Government meeting that the State Governments are also duty-bound to ensure that there are CCTVs installed and monitored at crime prone areas[34].
2008	In early 2008, the Cabinet proposed to authorise the police to determine the location of CCTV installations which was previously under the responsibility of the Minister of Housing and Local Government[35].

Source: Various sources

[30] *"Monitoring Safety in the City", www.dbkl.gov.my, November 2004*
[31] *"City Surveillance e-Guarding Lives" by Global Security Web, www.asmag.com, 14 February 2008*
[32] *"The Safe City Programme. Illustration of 23 Crime Prevention Measures", September 2007*
[33] *"Privacy and Human Rights 2006 – Country Reports" by Privacy International, 18 December 2007*
[34] *"CCTV: It's a State Priority" by The New Straits Times, 26 October 2004*
[35] *"Kaji Wajib Pasang CCTV" by Harian Metro, 9 January 2008*

With the Safe City Programme initiative, other states in Malaysia have also installed video surveillance in public spaces over the years as summarised in the following table:

Case Study: Perbadanan Putrajaya

The implementation of public video surveillance systems in Putrajaya started in 2000 for purpose of day-to-day operation in monitoring the maintenance of the city. The project was carried out in 2 phases with 74 cameras installed in Phase 1 consisting of both wired and wireless based. However, interference issues, bad signals and impeding line of sight with wireless systems, saw Perbadanan Putrajaya upgrading the wireless surveillance system to a wired system and additional cameras installed in Phase 2.

In Phase 2, all public video surveillance systems in Putrajaya are transmitted through a dedicated LAN fibre optics cable using IP based Bosch cameras with zoom capability between 200 to 250 meters and IndigoVision system. Therefore, the scope of use for the cameras in Phase 1 has since expanded to surveillance of public safety and movement, traffic monitoring, crime preventive measures and lately as a supporting evidence for court use. The systems in Putrajaya will be linked to the police by the end of June 2008 and will be monitored jointly by the police from July 2008 onwards.

As of today, there are 176 units of cameras installed in Putrajaya. These cameras are installed within the core island which covers Precinct 2,3,4,5 and 18 of Putrajaya and also outside the core island area. There are 100 units of camera in full operation with 76 still in installation and cabling stage. A central monitoring centre is located at the Control Room based in Perbadanan Putrajaya building itself. Monitoring is done on shift basis from 7:00am to 8:30pm and 8:30pm to 11:00pm by the Traffic and also Enforcement Division respectively.

Source: Perbadanan Putrajaya

Number of Video Surveillance Cameras Installed by Various Local Councils in Malaysia and Cost of Installation

Year	Authority	Area (Where available)	No. of Cameras	Cost (Where available)	Lease Contract (√)	*Source*
2004	MBSA	Shah Alam	10			*Berita Harian, 13 August 2004*
2005	MPAJ	Ampang	58	RM700,000/ month	√	*Kosmo, 4 October 2005*
2005	DBKL	Cheras, Brickfields, Sentul	10	RM2 million		*Berita Harian, 6 May 2005*
2006	DBKL		30	RM8 million		*Harian Metro, 23 January 2006*
2006	MBPJ	Section 12, SS2, Uptown	6 (16 cameras already installed prior to this)			*The New Straits Times, 11 August 2006*
2006	MBMB	Melaka	20			*The New Straits Times, 17 October 2006*
2007	MPPP	Komtar, Gurney Drive, Upper Penang Road, Jalan Masjid Kapitan Kling, Jalan Burmah, Jalan Sultan Ahmad, Sg. Nibong Bus Terminal	31(the first wireless broadband CCTV system at 4.9GHz)	RM5.8 million	√ (5-year lease contract)	*The Star, 13 January, 4 November 2007, and 12 June 2008*

Number of Video Surveillance Cameras Installed by Various Local Councils in Malaysia and Cost of Installation (Continued)

Year	Authority	Area (Where available)	No. of Cameras	Cost (Where available)	Lease Contract (√)	*Source*
2007	MPSJ	Subang Jaya, Seri Kembangan, Kinrara	100	RM700,000	1-year lease contract)	*The Star, 28 August 2007*
2007	Perbadanan Putrajaya	Persiaran Putrajaya, Dataran Putrajaya, car parks of housing areas, shopping mall	114 (additional to the 62 cameras installed prior to this)	RM21.6 million for 114 cameras and RM3.2 million for upgrade and maintenance of 62 cameras		*Utusan Malaysia, 25 October 2007*
2008	Kelantan State Government	Kota Bahru area	50		√	*Sinar Harian, 21 January 2008*
2008	MBSA	Jalan Bunga Melor, Seksyen 2, Jalan Permata, Seksyen 7, Express Bus Terminal, Seksyen 17, KTM, Seksyen 19	74 (26 cameras to be installed in July 2008 and 48 cameras to installed in December 2008)			*Sinar Harian, 17 April 2008*
2008	MPS	Pasar Besar Seremban, Persimpangan Stesen KTM	32	RM800,000 for the first 16 cameras		*Kosmo, 7 February 2008*
2008	MPK	Klang area	60 (26 cameras to be installed in Phase 1; 31 cameras Phase 2)			*Utusan Malaysia, 5 April 2008*
2008	MPKj	Kajang	40 (24 from Ministry of Housing and Local Government and 26 from State Government)	RM4.8 million		*The Star, 2 February 2008*
2008	DBKL	Public Housing Area – Sri Kota, Taman Wahyu II, Desa Tun Razak, Jelatek, Jalan Loke Yew, Sri Tioman, Jalan Hang Tuah, Gombak Setia	130			*The Malay Mail, 28 May 2008*
2008	MPT	Kuala Terengganu	31			*The Star 19 May 2008*

Although there are directives from the Malaysian Government on the installation of CCTVs in public areas, however, there are no laws governing the privacy rights in the use of CCTVs in public spaces. According to the Privacy and Human Rights 2006 – Country Report, the Bar Council chairman then expressed that there is no need to incorporate privacy safeguards for the use of CCTV in Malaysia's proposed Personal Data Protection Act, as long as images recorded "are used for the sole purpose of preventing criminal acts".

ESTABLISHMENT AND IMPLEMENTATION OF VIDEO SURVEILLANCE SYSTEMS IN PUBLIC SPACES

The deployment of video surveillance systems in a large public space is usually a long term programme. Like many other countries in the world, the establishment and implementation of a video surveillance system in public spaces involve substantial investments and resources from the local government authorities. Accordingly, it is essential to take into considerations the impact and costs that will be incurred. Usually, this also includes a considerable amount of planning and technical consultation and considerations required before the process of implementation.

Like many technologically driven equipment, the sophistication behind the video surveillance systems and applications will evolve due to technological advances over time. Evidently, this will impact video surveillance deployment, upgrade or extension plans in public spaces as video surveillance equipment installed will sooner or later become obsolete like most other devices. Other considerations will include the ongoing operating, management and maintenance costs of the systems and equipment involved which can add up if there is no proper planning, risking the system to be an expensive solution to the owners. Owners also had to understand that video surveillance systems at public spaces must be deployed and operated with integrity and respect for personal privacy and civil liberties.

PUBLIC VIDEO SURVEILLANCE SYSTEMS AND SERVICES DEPLOYMENT MANAGEMENT MODELS

Currently, there are various video surveillance deployment management models that have been adopted for public spaces. The types of management models are dependant on the following:

- Who will fund the provision of public video surveillance system?;
- Who will procure the video surveillance systems and equipment?; and
- Who will install, operate and maintain the video surveillance equipment and systems?

Generally, overseas trends show two generic types of management models in the video surveillance systems and services deployment:

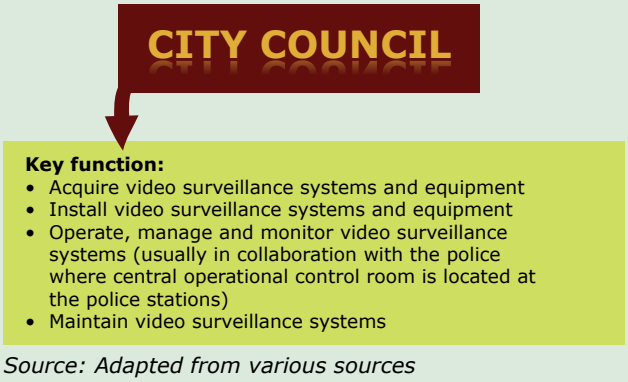
- Model one solely involves the local government authority in the whole deployment process from acquiring, operating, managing and maintaining the system; and
- Model two is often a joint-partnership between the local government authority and an external private service provider with the alternative to purchase or lease the camera by the local government authority.

Though some countries may have a standard deployment management model across their councils, countries like UK have differing deployment management models across their borough councils. Monitoring of public video surveillance is also sometimes done with the assistance of the local police authorities. Additionally, there may also be an involvement of a consultant by means of contract appointment, who is independent of any commercial interest in any equipment manufacturer, supplier or installer and is therefore able to exercise true impartiality and provide the best advice on design, delivery services and drafting of contract.

MANAGEMENT MODEL 1 - LOCAL AUTHORITY FUNDED AND OPERATED PUBLIC VIDEO SURVEILLANCE

In most countries, the local government authorities or city councils, who use the video surveillance as a situational crime prevention tool, are usually the predominant owners of the video surveillance systems and services in public spaces. This is due to the fact that the wide deployment of video surveillance in large areas is a costly project and the acquisition of video surveillance systems and equipment will be part of the capital expenditure for them. The advantage is to enable the local authority greater control over the systems. In summary, this model has the public video surveillance equipment purchased and owned by the local government authorities and they are responsible for the in-house operation, management and monitoring of the video surveillance systems.

Management Model 1



Source: Adapted from various sources

Case Study: Hasting District, New Zealand Crime Prevention Cameras

In Hastings, New Zealand, the crime prevention cameras or CCTVs are installed in the Hastings Central Business District, Havelock North Central Business District and Flaxmere Village commercial area. The establishment of CCTVs is undertaken by the Hastings District Council who is responsible for the capital outlay, installation, maintenance and line costs of the cameras in all Hastings City, Havelock North and Flaxmere central commercial areas. All items purchased by the Council remain as the property of the Council.

In this case, the Council owns the cameras, software, hardware and infrastructure of the CCTV systems. Whilst the overall operative management of the system is provided by way of the Hastings District Council security patrol, the housing or electronic monitoring and recording equipment is located at the police stations.

Source: The Hastings District Council, The Hastings Crime Prevention Camera Trust and Hastings Police Crime Prevention Cameras (CCTV): Operating, Protocols, Policies and Procedures

MANAGEMENT MODEL 2 - PUBLIC-PRIVATE OPERATED VIDEO SURVEILLANCE

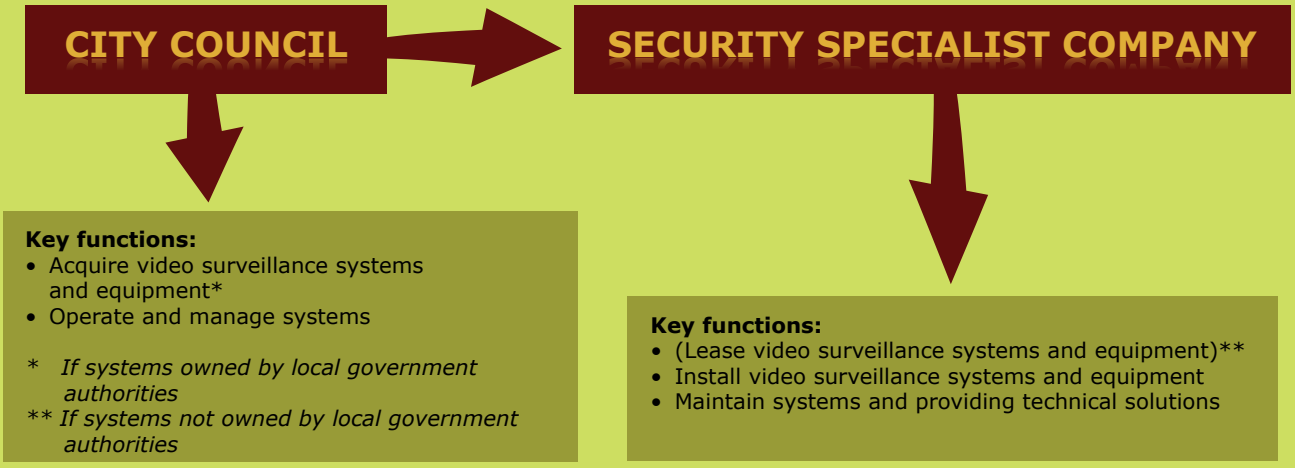
As the industry grows and technology advances, the world of video surveillance systems has become more complex. There is often a need now to engage security consultants or specialists with technical expertise in video surveillance systems and technology in a partnership or joint-effort with local government authorities for deployment of the system.

In this case, there are examples where local government authorities contract a licensed security consultants or operators with appropriate expertise to undertake the development and provision of video surveillance systems in terms of installation, maintenance and technical solutions of the systems or alternatively replace it with a contract between the local government authorities and the systems provider to lease the entire system for an agreed time period.

In Australia, the New South Wales Government Policy and Statement Guideline for the Establishment and Implementation of Closed Circuit Television (CCTV) in Public Places encourages the local councils to lease CCTV services rather than make a capital investment in their installation. According to the guidelines, programmes using leased CCTV equipment under a service contract may be more flexible than capital expenditure on CCTV cameras

as a permanent fixture. This is particularly relevant in light of rapidly developing technological advances in the area of video surveillance (Refer to diagram below).

Management Model 2
(Lease and) Installation and Maintenance Contract**



Source: Adapted from various sources

Case study: Oxford City Centre, UK, CCTV scheme

An example of City Council-owned system involving installation and maintenance contract with a security specialist company.

The public CCTV scheme in Oxford City Centre was established in 1999 by Thames Valley Police and the Oxford City Council. The Council appointed Quadrant Video Systems, one of the largest CCTV installation companies in UK and a member of the British Security Industry Association, to support both installation systems and the ongoing maintenance of CCTV equipment. Monitoring operation is via a secure room within St Aldate's Police Station. Oxford City Centre now has 33 CCTV cameras that were upgraded in 2002, including the installation of 12 new cameras funded by the Home Office under the Crime Reduction initiative.

Source: Oxford City Centre CCTV Scheme

Case study: Stevenage Borough, UK, Maintenance Agreement

An example of City Council-owned system involving installation and maintenance contract with a security specialist company.

The Stevenage Borough Council tendered a contract to supply an upgrade for their CCTV scheme. The tender was awarded to CCTV installation company, Quadrant Video Systems, for installing 17 additional colour cameras and a Vigilant digital recording system. However, to ensure that the surveillance system stayed in prime condition, the Council secured a prime solution that would help to extend the operational effectiveness of the town's CCTV surveillance monitoring system. The Council turned to the installer of the system, Quadrant, and examined the feasibility of their proposal for supplying a maintenance plan before awarding the company a three-year maintenance contract.

Source: Maintenance Agreement Case Study-Maintenance Provider the Key at Steranage, www.quadratcctv.com

Case study: Harborough District Public Space CCTV

An example of a leased system which was later reverted to ownership system.

CCTV schemes funded by the Home Office were developed in Harborough district, UK in 1996 for the towns of Market Harborough and Lutterworth. The system in Market Harborough is owned by the Council with monitoring provided by Lifeline services while the system in Lutterworth is leased with monitoring responsibilities undertaken by the police staff of Lutterworth Police Station. For 2007/2008, the Council agreed to provide substantial investment to upgrade the CCTV equipment from analogue to digital by allocating £48,000.

Over the years, the Council was aware that leasing the CCTV equipment in Lutterworth proved to be inefficient in providing a CCTV system for the town and decided that it should be purchased and maintained by the Council. Cost of leasing the equipment is at £7,800 per annum. The cost of one time purchase is £18,000 with annual maintenance of £2,000. As such, a decision was taken by the Council to purchase new equipment rather than committing to a new lease agreement.

Source: Harborough District Public Space CCTV Strategy 2007-2010

Case study: CCTV in Torbay, UK

An example of a leased system

CCTV was installed in Torbay since 1993 due to upsurge in violence, destruction and theft of property, particularly in Victoria Park and the Council's multi-storey car parks. The supply and maintenance of the cameras and communication links were provided under rental contracts with the Council staff operating the Control Room. The original installation cost of the CCTV system was approximately £250,000, the first phase costing £100,000 - all through a combination of Council funding and Government grants.

As a popular location for holiday makers, Torbay, in 2006, has 233 public surveillance cameras installed to help fight crime and deter anti-social behaviour. The cameras provided various public areas in Torbay a 24 hours-a-day monitoring. All cameras installed in 2006 in Torbay were still under a rental agreement since 1993 and the Council extended the lease agreement of another 15 months before considering other CCTV upgrade options available.

Source: Torbay Council Corporate Security Services, October 2001 and BBC News, UK - Council considers CCTV upgrades Council Considers CCTV Upgrader by BBC News, Torbay Council Corporate Security Services, October 2001

There is also a variant to management model 2. The variant involves the outsourcing of the installation and maintenance of the system to an installation contractor and monitoring and operation of the system to a security company. (Refer to diagram below)

Management Model 2 (Variant)
(Lease and) Installation and Maintenance Contract**

** If systems owned by local government authorities*
*** If systems not owned by local government authorities*
Source: Adapted from various sources

Case study: Hertfordshire CCTV Partnership

Like most other districts and boroughs in UK, Herfordshire had chosen to appoint the installation and maintenance of the public CCTV to a contractor, Quadrant Video Systems. However, in terms of monitoring the system, Hertfordshire has awarded the security company, Broadland Security as of 1 January 2008, a 5-year monitoring contract to manage the monitoring of the CCTV systems within the Control Room.

Source: Hertfordshire CCTV Partnership 2007 Full Year Report

Case study: Fareham Borough Council CCTV System

The Fareham Borough Council CCTV is managed jointly with the Gosport Borough Council in 2003. The Councils awarded a five-year maintenance contract to Associated Systems Services Limited (ASS). The contract includes cost of carrying out any necessary refurbishment and replacement of equipment on a rolling programme. The CCTV equipment and software used are purchased by the Council. The Council also awarded an annual monitoring contract to Genesis Security Ltd.

Source: "Future Proposal for Closed Circuit Television" by Fareham Borough Council

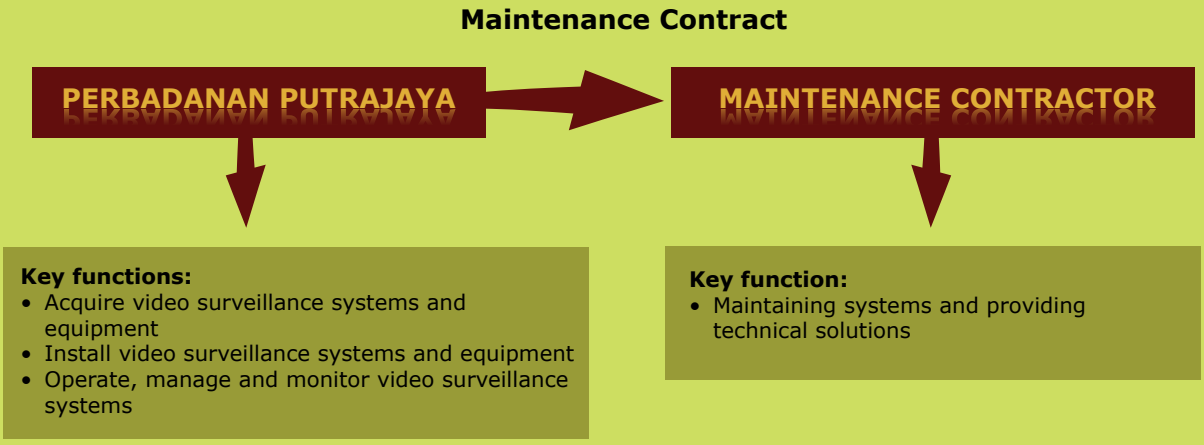
PUBLIC VIDEO SURVEILLANCE SYSTEMS AND SERVICES DEPLOYMENT MANAGEMENT IN MALAYSIA

Based on case studies from other countries such as UK and New Zealand, Malaysia comparatively has an almost similar approach in the management of public video surveillance systems and service deployment. However, like in UK, each local authority has diverse means of management approach and there are no similar methods across all local authorities. Case studies shown below are some examples of the management approaches that have been implemented.

Case study: Perbadanan Putrajaya

The public video surveillance system in Putrajaya is an example of a whole system and service which is managed by the local government authority, Perbadanan Putrajaya. This is almost similar to the Management Model 1. The systems and equipment for the public video surveillance is procured out right from a vendor by Perbadanan Putrajaya through an open tender system. Installation of the public video surveillance system is carried out by Perbadanan Putrajaya together with the management, operation and monitoring of the system.

However, in terms of maintenance, Perbadanan Putrajaya outsources it to an external party by way of maintenance contract which is also through a tender system. All expenses incurred for the public video surveillance project are borne by Perbadanan Putrajaya as part of its development budget.



Source: Perbadanan Putrajaya

Case study: Rental of CCTVs by Ministry of Housing and Local Government

In early January 2008, the Ministry of Housing and Local Government announced that it will install rented CCTVs in crime prone areas under the jurisdiction of 25 municipal and city councils. The Ministry had secured a special allocation of RM75 million from the Ministry of Finance on 2 January 2008. With this, the Ministry decided to use the funds to rent CCTVs and engage the service of the providers to maintain the facilities as it was a cheaper option than purchasing them. This is almost similar to the Management Model 3.

Source: "Ministry to Rent CCTVs, says Ong", The Star, 13 January 2008

Case study: Leasing option for State Government and Councils

The leasing model has been used widely by some of the State Government and Councils in Malaysia. An example is the Majlis Perbandaran Ampang Jaya (MPAJ) which spends RM700,000 per month for the cost of leasing 58 cameras to monitor traffic flow and identify crime offenders. Even the Penang Municipal Council has resorted to leasing CCTV cameras for crime surveillance instead of the option of outright purchase. The reason given was that leasing was a better approach as it saves maintenance cost.

Subsequently, it would prevent the Council from owning obsolete equipment as CCTV systems like any other technology devices need to be replaced approximately every five years. Similarly, in Kelantan, the State Government has opted to lease the 50 CCTV cameras to be installed in Kota Bahru, Kelantan to ease the cost of burden of the State Government.

Source: "RM700,000 Sewa CCTV", Kosmo, 4 October 2005, "Penang Council to Rent CCTV Cameras", The Star, 13 January 2007, and "50 CCTV akan Dipasang di Kota Bahru", Sinar Harian, 21 January 2008

KEY FINDINGS

Although the public video surveillance is generally funded by the State Government or Local City Councils or Municipal Councils, like in other countries, there is a mixed approach to management of public video surveillance systems and service deployment in Malaysia. While there have also been others who solely undertook the deployment projects themselves, some local government authorities have outsourced the entire deployment works to an external private security party through a contract agreement or go into a joint-partnership with the external parties in terms of leasing, installing and maintaining the systems and equipment.

An outsourcing or leasing contract may not be feasible and cost effective to some local government authorities in the long run due to the higher cost required, minimum capital availability, and development and operation funding available to them. As funding is also dependant on the sum of monies from the Ministry, systems deployed are usually by phases.

ISSUES AND CONCERNS FOR CONSIDERATION

During the implementation of video surveillance in public spaces, there are a few issues and concerns to be considered as these involve the recording of public images and activities in general. Implementation of a video surveillance system in public spaces is no small task in view of cost and other resources involved as discussed so far. If video surveillance is deemed a necessity after cost saving alternatives have been exhausted such as proper and ample street lighting in the affected areas and similar measures, the other issues on liability and legality to be considered as discussed here are privacy, workplace surveillance, liability incurred and limitation on disclosure.

PRIVACY

Many have argued that the act of public video surveillance itself is an invasion of right to privacy. But most tolerate it as a minor inconvenience they must deal with in order to experience the benefits and assurance gained from the added security achieved. For this reason, video surveillance in public spaces must ensure that:

- It does not intrude to an unreasonable extent the recording of an individual's personal affairs;
- Efforts should be taken not to include monitoring and recording of private residences or at least seek consent from owners of residences if it is within the camera view; and
- Cameras are not placed at public facilities such as inside public toilet facilities.

As a guide, consideration is given to allocate video surveillance cameras at the following public spaces:

- Identified crime hot spots;
- ATMs and banking institutions;
- Licensed premises;
- Bus stops, taxi ranks, car parks and railway stations; and
- Places frequented by potentially at risk groups such as the elderly and young people.

WORKPLACE SURVEILLANCE

In some countries, the loss of privacy rights in the workplace is a growing concern among employees. However, in terms of video surveillance in public spaces, there will be many cases where work activities of street cleaners and garbage collectors are indirectly or covertly recorded by the CCTVs located at the area of work.

Covert surveillance is illegal unless an authority is given like for the purpose of monitoring an employee to see if he is involved in any unlawful activity. The local council as employers of these workers must therefore ensure that employees are informed that video surveillance is there for other reasons and not for the purpose of monitoring their daily work activities.

LIABILITY

According NSW Government Policy Statement and Guidelines for the Establishment and Implementation of CCTV in Public Places, local councils should be aware of the potential for increased liability which may be incurred when considering the installation of CCTV. By taking on the responsibility of ensuring public safety within the CCTV area, a local council may be found liable should a person be injured in some way. Therefore, they must ensure that surveillance cameras used for monitoring public safety must always be in a working condition. CCTVs installed will be a liability when it is in a non-working condition, unsupervised or is pointing in the wrong direction. Local councils should seek independent legal advice on this issue prior to installing CCTV equipment.

LIMITATION ON DISCLOSURE

The images that have been collected or accessed from CCTV should have limitation of disclosure and not be easily given without consent to any other irrelevant authorities or bodies such as the media. It also cannot be and should not be used for commercial or trade purpose such as advertisement. Privacy guidelines for CCTV should build on public domain as well as guidelines on the use of recorded images.

CONCLUSION

The video surveillance market is a growing market although at present it is still in transition stage from traditional analogue devices to digital networked and to transmission over IP network base. Surveillance systems have improved dramatically over the years as technology advances. This market growth depends on evolution of technology and the eagerness of the industry to embrace the technology. There will be further improvements in the areas of product development, network, investments and systems integration.

Product Development

Surveillance products are expected to be increasingly able to interoperate as the transition from analogue to digital and eventually fully IP network-based.

Network Availability

Network availability is to guarantee an efficient flow of data in a timely, accurate, fast and affordable delivery in high volume and with quality images. Improvement in compression technology and efficient use of bandwidth are crucial to ensure no congestion at the network.

Investment

The adoption of IP network in video surveillance is seen to take place slowly and in stages as operators maximise usage of their analogue and digital instruments. Eventually there is a need for added investment into hybrid networks that link analogue systems to digital and later IP or in simpler terms to build a bridge across old and new networks. Hybrid systems however, require lower capital investment compared to a single mode traditional system.

System Integration

As consumers are deemed king in the surveillance market as well, they will eventually want to integrate all their applications into one system. For example, CCTV, alarm, access control and so on into a single system.

Overall, the use of video surveillance in public spaces is poised to fully take up IP to save cost and other benefits it offers in the long term. With many other countries increasingly implementing such systems due to their proven effectiveness in crime prevention, Malaysia may well broaden their use to not only urban areas but non-urban as well. The wider implementation plan especially by the local authorities is expected to augur well for the overall growth of the industry in Malaysia.

ACRONYMS

ADSL	Asymmetric Digital Subscriber Line
ATM	Automated Teller Machine
AVC	Advanced Video Coding
CCTVs	Close Circuit Televisions
CIF	Common Intermediate Format
DBKL	Dewan Bandaraya Kuala Lumpur or Kuala Lumpur City Hall
DVD	Digital Video Decoder
DVRs	Digital Video Recorders
IP	Internet Protocol
ITIS	Integrated Transport Information System
EMEA	Europe, the Middle East and Africa
EMI	Electromagnetic Interference
FCC	Federal Communications Commission
IR	Infra Red
ISDN	Integrated Services Digital Network
ITU	International Telecommunication Union
LAN	Local Area Network
MBMB	Majlis Bandaraya Melaka Bersejarah
MBPJ	Majlis Bandaraya Petaling Jaya
MBSA	Majlis Bandaraya Shah Alam
MJPEG	Moving Joint Photographic Experts Group
MPAJ	Majlis Perbandaran Ampang Jaya
MPEG	Moving Pictures Expert Group
MPK	Majlis Perbandaran Klang
MPKj	Majlis Perbandaran Kajang
MPPP	Majlis Perbandaran Pulau Pinang
MPS	Majlis Perbandaran Seremban
MPSJ	Majlis Perbandaran Subang Jaya
MPT	Majlis Perbandaran Terengganu
NAS	Network Attached Storage
NSW	New South Wales
NVRs	Network Video Recorders
PBT	Pihak Berkuasa Tempatan or Local Authorities
PTZ	Pan-Tilt-Zoom
QCIF	Quarter Common Intermediate Format
RFI	Radio Frequency Interference
SAN	Storage Area Network
SQIF	Sub Quarter Common Intermediate Format
UTP	Unshielded Twisted Pair
VCA	Video Content Analysis
VMS	Video Management Software
VCRs	Video Cassette Recorders

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