THE PROS & CONS OF DIGITAL SURVEILLANCE TECHNOLOGY

CONTENTS

Abstract – **This paper explains the differences between digital and analogue technologies as they apply to CCTV surveillance systems.**

The progression of surveillance systems from purely Analogue, via the use of Digital Video Recorders (DVRs), to Networked Surveillance systems is outlined. Each system is explained and the advantages and disadvantages inherent in each are discussed. Additionally, the reliability and admissibility of evidence generated from digital video footage is addressed.

It is widely accepted that the flexibility and scalability inherent in networked security and surveillance systems makes their widespread adoption inevitable. This paper explains the terminology and dispels the confusion that too often makes the technology appear more complex than it is.

1 INTRODUCTION

It is difficult to imagine what modern living would be like without ready access to reliable, economical and efficient means of communication. Communication systems are found wherever information is to be transmitted from one point to another. The telephone, radio and television are common, everyday examples of communication systems. Information storage is possible via magnetic tape, video, CD and DVD - all familiar technologies.

The recent explosion in information technology has occurred as a result of advances made in communications systems. One of the fundamental advances that made this possible is the replacement of analogue signals and systems with equivalent digital technologies[1].

In this paper we begin by defining the term ***digital***, before examining the manner in which digital technologies have changed the profile of Close Circuit Television (CCTV) surveillance systems and the advantages and disadvantages to the adoption of digital technology. This document uses the term Network Surveillance to refer to a fully digitised, Networked Surveillance system. However, the term IP-surveillance is often used to refer to either fully digitised systems or to those incorporating DVRs.

[1] *Interestingly the evolution in the way information is transmitted and stored could be considered a regression – the first digital system was developed before analogue systems, with the advent of the telegraph system in the 1850s.*

2 Definitions of Analogue & Digital Technology

The evolution of contemporary electronic systems has seen a progression from purely analogue signals and systems, to those that contain a mixture of analogue and digital, to the current trend where purely digital systems are becoming increasingly predominant. Applications that were once exclusively analogue, such as sound recording and reproduction, have become entirely digital and have obtained numerous benefits as a result.

2.1 Analogue Technology

Analogue information sources produce messages that are defined on a continuum where the information is represented by a continuously varying quantity – a microphone is an example of such a system, where the output voltage describes the sound over a continuous range of values.

An analogue sound recording may be likened to making a photocopy, where processing the signal is the equivalent of recopying a photocopy – it can be done, but only to a certain extent because of the deterioration that occurs. More pertinently this can also be seen in the repeated copying and playback of videotape recordings.

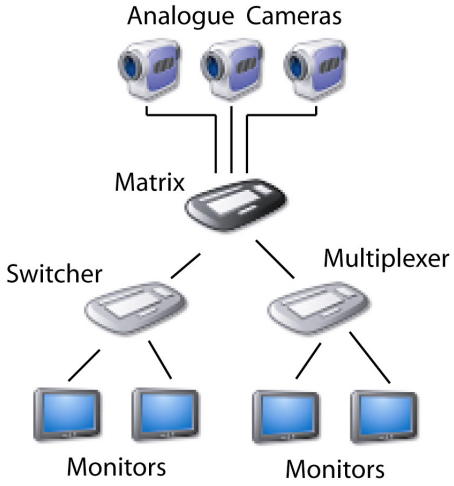
2.2 Digital Technology

A digital information source produces a finite set of possible messages, the information represented by discrete values. A typewriter is an example of such a system, where there are a finite number of characters (or messages) that can be typed (or emitted by this source).

Digital sound is recorded as a series of numbers that measure pitch and volume at a given instant in time. Processing the sound is extremely precise and consequently the signal is far more robust than its analogue equivalent – allowing repeated copies to be made, each a perfect duplicate of the original. Digital signals can be seen (and heard !) to be virtually immune to noise, distortion, crosstalk and other quality problems inherent in analogue systems.

It is possible, and desirable, to convert analogue data to digital and vice versa; this is performed by devices known as D/A (digital-to-analogue) and A/D (analogue-to-digital) converters. The former simply carries out a mathematical "join-the-dots" on the discrete values of the digital signal, while the later periodically measures (or samples) the analogue signal.

3 Analogue CCTV



Traditional, analogue video transmission is done using coaxial cables (or occasionally high quality fibre-optic cables) with the transmission of a standard composite video signal. An analogue camera transmits an analogue signal over cabling and via a switching device and/or a matrix terminating at the display or recording device.

An alternative takes advantage of the large amount of existing unshielded twisted pair (UTP) cabling, such as telephone lines, saving on the cost of installing new coaxial cable by transmitting the signal along UTP cables. However, complicated termination equipment is required to aid in the transport of the video signal over UTP, particularly if good results are to be obtained over long distances.

Analogue systems have a number of disadvantages:

- **Proprietary Technology** – Analogue systems are generally proprietary and will not inter-operate with those of other vendors.
- **Expensive to Install & Maintain** - The installation and maintenance of analogue systems can be expensive, particularly as the number of cameras increases, because specialist skills that are not available within most companies, are required.
- **Lack of Remote Monitoring** - To view and analyse video footage, a user must physically be at the monitoring site or central control room. Remote viewing is not possible.

- **Labour Intensive** - An analogue system must be continually manned with laborious procedures for changing tapes, archiving tapes and retrieving footage if an incident has occurred.

- **Expensive, Low Quality Storage** - Video footage is recorded onto cassette tapes that reduce the resolution and clarity of the images stored on them. The end user also incurs an expensive, recurring cost for purchasing tapes (that should not be re-used) and for their storage.

- **Laborious Retrieval of Video Footage** - The retrieval of video footage is highly time consuming and could take, at best, hours and, at worst, days.

- **Difficult to Expand** - The scalability of an analogue system is limited by the capacity of the matrices and switchers. This means that future requirements must be predicted and systems installed with some over capacity, increasing the initial purchase cost.

Analogue systems are typically dumb systems. They have minimal intelligence and no automated analysis of the video data is possible. Human intervention is required to retrieve manipulate and evaluate stored footage. The integration of these systems with complementary security technologies – such as door-entry, fire detection or biometric systems is not possible. However, for simple, small sites, where surveillance requirements are not expected to change, they are inexpensive and simple to operate. Operational knowledge about Analogue systems is widespread within the security industry.

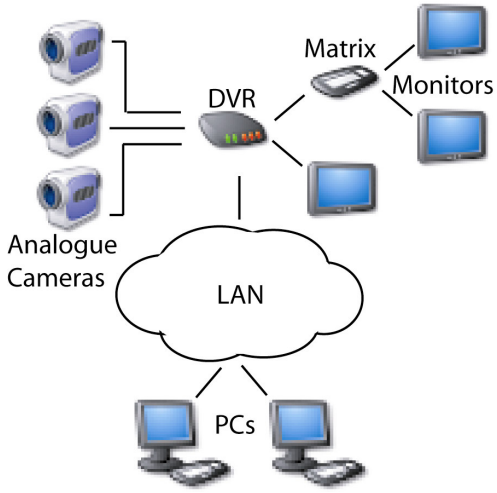
4 DIGITAL CCTV

The issues and problems with analogue systems, that until recently were regarded as an acceptable annoyance, are increasingly no longer tolerated. Technology, such as the Internet and the intranet (the internal network within a company) and the ever-increasing computing power that is now readily accessible, has provided the tools to address and resolve these issues.

Harnessing this new technology is a challenge for traditional, analogue CCTV manufacturers. They must learn and understand a fast growing and moving technology and they must devise new CCTV architectures to take full advantage of the capabilities that digital technology offers. Manufacturers are converting to the digital world in stages so that the learning process is gradual for themselves, the installers and the end users of existing analogue CCTV systems.

This section explains the two common ways in which digital technology has been applied to the CCTV industry – the use of digital video recorders (DVRs) and network surveillance systems and the benefits and drawbacks that each brings.

4.1 THE DIGITAL VIDEO RECORDER (DVR)



CCTV systems first entered the digital age in the late 1990s and early 21st century when the first Digital Video Recorders (DVRs) became available. The DVR is a direct digital replacement for the VCR for the storage and retrieval of video footage. Video footage from analogue cameras is converted to a digital form and compressed before being stored onto the recorder's hard drive.[2]

DVRs allow desktop PCs to access recorded video footage via a LAN connection. They resolve a number (but not all) of the problems and issues that are inherent in analogue surveillance systems:

- **Efficient and Flexible Storage** – Video sequences can be stored when motion or other predefined events occur, on request or can be programmed to store at specific times for designated periods.

- **Reduced Operating Costs** - The expense associated with operating a VCR and videotapes is eliminated. (Unlike videotapes, digital storage media have an almost unlimited lifetime and you do not have to remember to switch videotapes!)

[2] *For information about compression technologies, please request a copy of the Salent White Paper 016/2004 – Differences Between Compression Technologies.*

- **Automated & Remote Monitoring** - Digital technology makes automated monitoring and analysis of video footage possible. This, combined with the ability to monitor multiple sites remotely, realises significant cost savings in respect of manpower and improves the quality and consistency of the work undertaken.

- **Easy Migration** – DVRs support analogue cameras, allowing easy, cost effective integration with existing analogue systems.

- **Faster Data Retrieval** - No more screening through hours of videotape to find a single frame. Utilising digital CCTV, users can retrieve video footage instantly, rapidly searching for video sequences by date and time, location, camera, alarm-activation or motion, using sophisticated data mining technologies.

- **Higher Image Quality** - Even at the most basic level, digital video images are superior to those recorded on analogue systems. Sharp, crisp images are stored which can be viewed over and over again without degradation or deterioration

The advantages of DVRs when compared to purely analogue systems are significant. However, they do not solve all the issues associated with analogue systems and it is important to recognise that they have their own limitations:

- **Matrix Display Limitations** - DVRs allow playback via a PC from anywhere but rarely have the ability to support more than one or two conventional monitors. Typically, the multiplexing features available from analogue systems (such as split displays, picture in picture etc) are not available via a DVR. Remote monitoring is highly beneficial, but monitoring a number of locations remotely often demands the ability to support a wall of monitors. The matrix capability (routing any camera to any monitor) is lost with a DVR and if a number of monitors are required, a combination of separate matrices, multiplexers and switchers must be used.

- **Limited Storage Rates** - DVRs can only process and store a pre-defined number of frames per second (fps) – typically 60 to 240 and more recently 480. The total frames per second must be shared between the cameras. Adding more cameras means that fewer frames per second can be stored per camera. (Although systems do exist that allow specific cameras to have higher frame rates at the expense of those in other cameras.)

- **Specialist Infrastructure Required** - DVRs monitor analogue cameras. This means that a large, specialist infrastructure must be installed and maintained. Each camera requires larger runs of coax cable.

- **Limited Scaling Ability** - DVRs typically have a fixed number of camera inputs (8, 16, or 24) and a system can only be expanded in multiples of DVRs. A system with 17 cameras, for example, requires either two 16 input DVRs or a single 24 input DVR with a corresponding cost increase to support one additional camera.

Concerns about the cost of surveillance systems that incorporate DVRs have diminished. While the initial cost of DVRs is greater than a rack of VCRs and video switchers, this is quickly recovered with the savings made in VCR tapes and the manpower required to monitor VCRs and swap tapes over. The ease of use, on going cost savings and support of remote access has made the DVR a preferred choice when replacing VCRs, or for small, contained sites with a limited numbers of cameras.

4.2 DIGITAL NETWORK SURVEILLANCE

To truly harness the full potential of digital technology, and to generate further cost savings, another revolution in digital CCTV is emerging. Network Surveillance not only provides all the benefits associated with DVRs, but offers many other benefits that the use of DVRs cannot achieve, while simultaneously overcoming their limitations.

The increasing speed and size of the Internet, together with the proliferation of company LANs, has allowed a more scalable, flexible approach to CCTV systems.

The principle of Network Surveillance is to digitise the video from surveillance cameras at the earliest opportunity and to utilise the existing IT LAN infrastructure to transport the signal thereafter, significantly reducing the amount of conventional CCTV cabling required. The supply of power to network devices via the LAN cable (Power over Ethernet) reduces costs further.

A digital video camera, or an existing analogue camera with a local digital server board, transmits a digitised signal via the LAN into a display or computer. The computer manages and manipulates the digitised video data from all available cameras and can display, store or relay the video signal via the Internet to any accessible terminal – from local clients to geographically remote devices such as lap-tops, PDAs, mobile phones etc.

Currently, the availability and range of networked digital cameras is small in comparison to the feature set and types of analogue cameras available. The Video Server boards that digitise the video output from an analogue camera locally offer a good compromise and typically offer a number of enhanced features. Salent's OmniCam, for example offers, amongst other things, Intelligent Motion Detection, Automated Suspect Tracking and PTZ control.

This latest generation of Network Surveillance products offers a highly scalable and flexible Virtual Switching Matrix (VSM), that enables truly distributed video throughout the network. The digitised video can be routed to any display server on the network or on the Internet or can be viewed on a conventional PC monitor. The latest display servers (such as Salent's OmiView) provide full multiplxer capabilities, such as split screens and sequenced displays.

A substantial advantage inherent within Networked Surveillance systems is that it is not necessary to install and maintain a separate CCTV network. The existing computer networks and IT infrastructure, managed directly by company can be utilised. This affords a level of professional management not previously experienced by surveillance systems that vastly reduces the total cost of ownership, by reducing expenditure on dedicated cabling design, purchase, installation, testing and maintenance.

Additionally, the use of standard, internally managed IT infrastructure can extend to the use of standard servers for storing the video streams, for controlling access to the system and for system configuration via standard data bases. Set-up and control can take place from any point on the network.

Scalability is an inherent advantage of LANs and devices can be added to any standard Ethernet port and automatically detected by and incorporated into the system. These devices need not just be cameras, the possibilities are endless – an IP enabled door entry system could, for example, communicate with the security management software, allowing fully integrated management of all security systems from a single interface.

Unlike traditional, analogue CCTV a digital, networked system offers future-proof technology. The size and scope of the digital network transcends anything that may have gone before. Video signal can be transmitted independently of the medium, using technologies such as Gigabit Ethernet or wireless LAN or can be interfaced to other networks via products supplied by CISCO and Marconi, for example.

The use of Open Standards and standard IT infrastructure and servers ensures that system upgrades are cost effective. Servers previously used for video storage can be utilised elsewhere if an upgrade the surveillance system means that servers with a higher specification are required. Other benefits inherent with Networked Surveillance include:

- **Improved Audit Trail** – All user interactions and system events can be time-stamped and logged automatically.
- **Archiving** - Important information can be archived to FDD, HDD, CD-R, or DVD for later retrieval.
- **Noise Immunity** - Digital systems are virtually unaffected by noise.
- **Flexible Distribution** - Stored data can be transmitted and retrieved across the building, between sites or across the world. Video images can be viewed and saved remotely, retrieved, copied, printed, faxed and e-mailed directly by the surveillance system.
- **Reduced Obsolescence** - Digital system software can be upgraded to extend its life. The adoption of Open Systems[3] components and architectures allow multiple vendors to support interoperating products.
- **Flexible Transportation Medium –** The utilsation of the standard network means that video and control information can be transported over a number of media including wireless, optical fibre, and RF (radio frequency). Whilst unlikely in any one particular application, it is possible to integrate all these video transport techniques into one system, giving users flexibility and choice in their preferred delivery mechanism.

[3] *For more information on Open Standards please request a copy of Salent White paper 015/2004 – Open Standards.*

4.3 Evidence Generation From Digital Images

A concern often cited in regard to digital CCTV is the admissibility of evidence produced from digital video footage in court. Everyone knows the ease with which digital images can be changed or touched up. Standard photo editing software provides very powerful features that can dramatically change an image.

In 1992 the Home Office produced guidelines (Digital Imaging Procedure) that recommend best practices for anyone handling digital footage. Manufacturers of digital systems have taken great care to address these issues and one of the most important tools at their disposal is the generation of an audit trail. This ensures that the evidence generated, is traceable and can be authenticated, either by the operator or by the system's manufacturer, ensuring that there are no problems with the admissibility of the video evidence collected.

A good digital system should provide a straightforward procedure to help generate any evidence material required. Salent's Omnis system, for example, offers the ability to select evidence based on time, camera and/or specific system events, such as the detection of movement or the triggering of an alarm. An evidence folder is generated that provides a full audit log of the incident and the steps taken to produce the evidence folder. All the information is digitally keyed (or signed) to ensure that that no changes can be made to the recorded footage or the evidence folder without detection.

In 1998 the House of Lords Science and Technology Committee was assigned to look at digital recording techniques and concluded that they could find no reason why digital evidence could not be used in court.

5 Conclusion

The security industry has evolved from feet and eyes on the ground, to those seated at monitors and latterly, via Digital Network Technology, to automated, intelligent surveillance. The adoption of digital technology by the security and surveillance industry is an inevitable, natural progression. Superior image quality and the ease with which images can be processed have already led to the wide adoption of digital technology for photography, broadcasting and home video recording. A lack of understanding of digital technology has been prevalent within the security industry and this has led to it lagging behind many comparable industries.

In an increasingly digital world the transition to digital network surveillance is a logical, cost-effective, progressive step. It resolves the problems associated with analogue surveillance systems and, unlike the use of DVR's does not introduce new problems of its own.

Currently, while there are cost advantages to the use of DVRs for small surveillance systems, the majority of sites can achieve substantial benefits and cost savings from a Networked Surveillance solution. Networked Surveillance provides a clear, evolutionary path for sustained development and system enhancement. The use of standard IT equipment and servers will continue to drive costs down until ultimately, Network Surveillance is the logical choice in all circumstances.

6 Further Information

Salent Technologies has a vast amount of experience in both analogue and digital network technology and can provide valuable guidance when specifying the requirements of a Networked Surveillance system. Please contact us to obtain product information and guidance, or to arrange a product demonstration.

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