AXIS COMMUNICATIONS

WHITE PAPER

TECHNOLOGY AND APPLICATIONS

From VCRs to IP-Surveillance

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1 Introduction – It's a Digital World

With little fanfare or many of us even taking notice, it's become a digital world. Look around, so many products incorporate digital technology. Cars, cameras, and microwaves all utilize digital technology. Personal digital TV recorders are rapidly gaining popularity. Many feature film directors now shoot with digital cameras. And all those MP3 players? That's digital technology providing listeners with thousands of songs in a device you can hold in your hand. How has this process of digitization come about, and what are the effects for the security industry?

The process of digitization makes products function better and more efficiently for the end user, and over time they also become cheaper—a powerful combination. Most products follow an evolutionary path beginning with discovery, through stages of constant technological innovation, and then mass production. A good example is the radio. In the 1960s, radios were bulky, expensive pieces of furniture. The 70s saw the advent of the tabletop transistor radio. Now, what once occupied an entire corner of the living room can now be added to your watch at the cost of a few dollars.

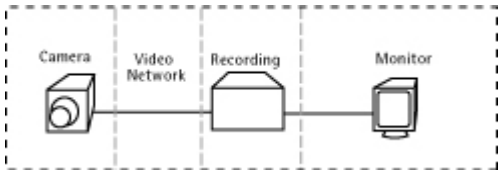
The digitization process starts with first generation products that are not as good as the existing technology and are usually many times more expensive. Typically, enthusiastic "early adopters" are the main market for this product generation, users who appreciate it simply because the technology is new. With continuous product improvement come better-functioning products, lower costs, and a steadily growing customer base. After a few years, the product based on digital technology begins to dominate the entire market.

2 The Digital Evolution of CCTV Surveillance

This same process of digitization has been playing out in the CCTV industry over the last few years, as the number of manufacturers has grown and prices have fallen. Recent reports by both Frost & Sullivan and J. P. Freeman & Co., Inc. point to 2002 as the year in which digital technology surpassed analog recording in terms of demand. Digital video recorders (DVRs) now constitute up to 75% of new CCTV systems. The terror attacks of 9/11 and subsequent events have hastened the search for the best technology to solve security, surveillance and business needs. But as end users have become more familiar with DVR technology, they've realized that the DVR represents just one more step in the ongoing digital evolution of CCTV systems. Innovation has continued beyond the DVR, and a viable, cost-effective alternative has emerged: *IP-Surveillance* or Networked Video. IP-Surveillance technology offers video transferred over IP infrastructure—finally a surveillance concept that is fully digital.

3 From VCR to IP-Surveillance in Four Stages

Analog CCTV systems became popular in the 1970s for security and surveillance applications. The typical surveillance system comprises four components: camera, video network, recorder, and monitor. Over the last 10 years, one by one, these four components have been digitized. The diagram below outlines how these components are connected.



Digitization of the Camera. Digitization in the CCTV arena began around 1990 when digital cameras (based on CCD sensors) replaced analog tube cameras. These CCD cameras were *partly* digital, but they still used analog connections of coax cable for the composite video, and recording was still done to analog VCR tapes. We'll refer to this technology period as the **VCR era**.

Digitization of the Recording. Around 1996, the DVR's recording function was the next component to become digital. The main benefits to the end user from this next step of digitization included, no more changing tapes, recording quality was consistent, and recorded event searches became much more efficient. While more efficient, the DVR still had analog coax inputs and an analog output for the monitor. In fact, the DVR was an analog-digital hybrid. This period was the start of the **DVR Era.**

Digitization of the Monitor. The second half of the **DVR Era** saw a network connection established for the DVR by digitizing the monitoring station through employing a PC. In the last two years, DVRs increasingly come equipped with a network or modem interface so that the recorded images can be monitored remotely, via monitoring software, using a standard PC.

Digitization of the Video Network The final obstacle to complete CCTV digitization is the link from the camera to the DVR. For many of today's CCTV systems, this is the last bastion of analog technology: the coax cable. IP Network cameras and video servers have hammered the final nail in the analog coffin by making the link from the camera to the recorder digitized, using standard computer networks (Ethernet networks), Internet, or even wireless technologies. Digital imaging, combined with networking, enables a whole new range of system-level functionality and cost-efficiency. This final stage, which has just begun, we call the **IP-Surveillance Era**.

4 Towards Total Digital Functionality

As we've seen, the DVR is actually hybrid technology—part digital, part analog. That's why you still have all those analog coaxial cables. A DVR is basically an analog multiplexer added to a proprietary computer. Going one step further to a totally digital system makes perfect sense since a CCD (via an A/D converter) already generates a digital image, and the recording on the hard drive in the DVR is also digital. Why do a digital-to-analog conversion in the camera, transmit the signal over an expensive coax cable, just to make an analog-to-digital conversion on the DVR? These multiple conversions slow down performance and increase the total cost of the system.

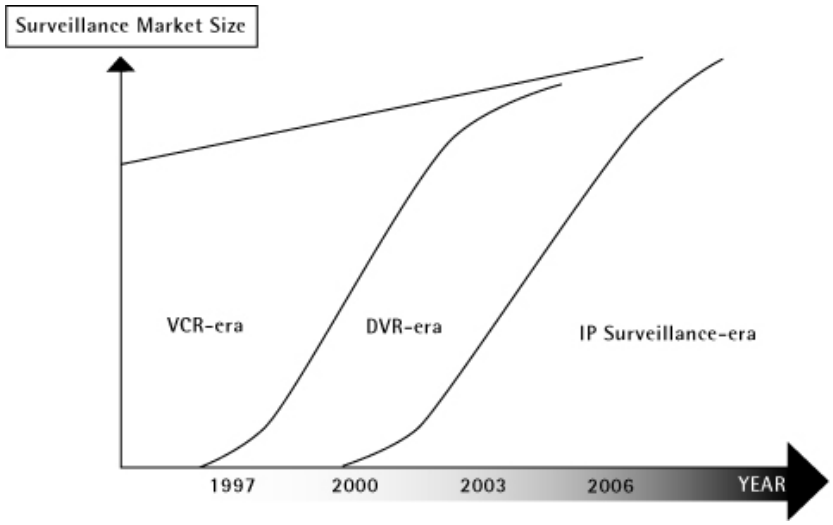
First, let's evaluate the extent of digital penetration for each of our three "Eras" described above:

- The **VCR Era** is coming to an end. Only some 25% of new installations in 2002 were using VCRs, and that number continues to decline.

- The **DVR Era** is about 75% complete, according to the 2003 J. P. Freeman and Co., Inc. CCTV report.

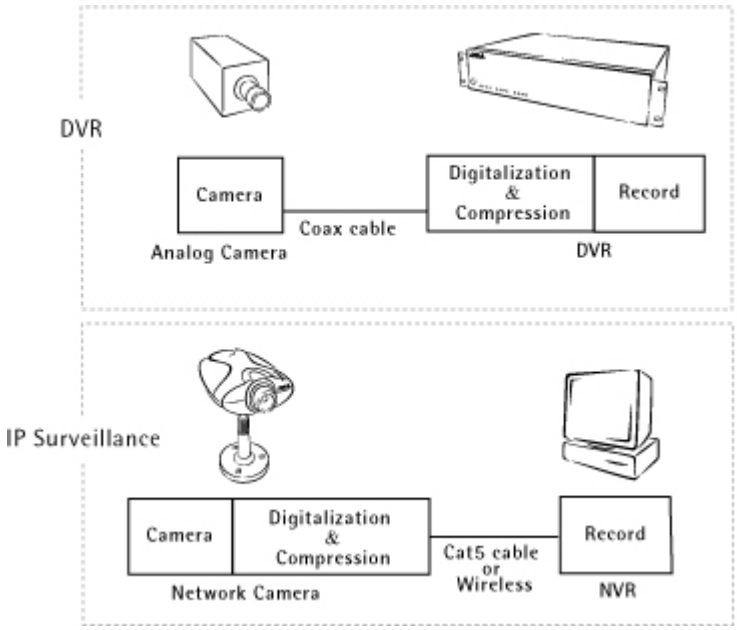
- As noted, the **IP-Surveillance Era** has just started, showing only about a few percent points penetration today. Nevertheless, the unstoppable evolution of technology and the obvious appeal of IP technology means this final stage is rapidly accelerating. 2002 was a breakthrough year for this technology, with strong growth in 100+ camera installations in governmental, education, retail, transportation and financial institution markets. Axis Communications was a major beneficiary as this technology came of age—surpassing 200,000 network video products installed.

The diagram below illustrates our discussion how the Surveillance market has evolved from the VCR to the IP-Surveillance Era, via the DVR era. We can clearly see the history of penetration and how growth will proceed over time from the present market situation:



5 DVR and IP-Surveillance Concepts in Action

At the most basic level, how do the DVR and IP-Surveillance concepts compare? Let's examine a single video channel:



In each diagram, where is the focus of activity? With a DVR, the processes of digitization and compression occur in the recorder unit. But with IP-Surveillance most of the "action" moves to the camera, including "intelligence" functions like motion detection and others. Gradually, this more intelligent solution is creating "smart" cameras. For IP-Surveillance, the recording function is performed by a network video recorder (NVR), which is a standard PC Server loaded with video recording software.

When compared to the DVR, the IP-Surveillance solution sacrifices no functionality; it simply moves it from the DVR to the camera. This helps explain why the network camera is more expensive—it incorporates most of the DVR's functions.

6 Comparing DVR and IP-Surveillance Concepts

The DVR and IP-Surveillance concepts share a number of beneficial features and functions: recording to digital hard disk; no tape maintenance; high and consistent image quality; fast, easy image retrieval, access to recorded video over IP networks; and a few more. However, a more comprehensive comparison of the two technologies reveals how IP-Surveillance technology offers a number of significant advantages over a standard DVR:

- **Scalability.** IP-Surveillance scales from one to thousands of cameras in increments of a single camera. There are no 16-channel jumps like in the DVR world. Increase frame rate and storage by adding hard drives and PC servers to

the network. Any frame rate for any camera at any time is available—no limitations.

- **Utilizes more cost efficient infrastructure**. Most facilities are already wired with twisted pair infrastructure, so no additional wiring (an expensive part of the CCTV install) is required. In cases where there is no infrastructure, installation of twisted pair is a fraction of the price of coax wiring. Using twisted pair also means that no separate wiring for PTZ control and power to the cameras is required. In addition, wireless networking can be used where cabling is impractical or expensive.

- **Network convergence.** Only one type of network (IP) connects and manages the enterprise for data, video, voice, etc.—making management more effective and cost efficient. This advantage reflects the change within many organizations today, where Security includes both IT and physical security.

- **Systems integration**. IP-Surveillance technology provides an open, easily integrated platform. As system integration becomes increasingly critical, be assured that access control, heating and ventilation, process control, and other systems and applications can be effectively integrated.

- **Remote accessibility.** Any video stream, live or recorded, can be accessed and controlled from any location in the world over wired or wireless networks.

- **Intelligence at camera level.** Motion detection, event handling, sensor input, relay output, time and date, and other built-in capabilities allow the camera to make intelligent decisions on when to send alarms, when to send video, and even at what frame rate to send the video. Thus, improving information access and decision-making.

- **Increased reliability**. IP-based data transport enables off-site storage and the ability to use redundant infrastructure, server and storage architecture. By using standard server and network equipment, replacement time for faulty hardware is considerably shorter than if using proprietary DVR solutions. Management software provides real-time system health status and information on preventive measures.

- **Open and interoperable**. Unlike the DVR "black box," closed solution approach, IP-Surveillance is based on open standards allowing use of products from different manufacturers, such as switches, routers, servers and application software—significantly lowering costs and increasing performance choices.

- **Lower system cost.** In many installations, the IP-Surveillance system has proven to be a lower cost alternative. Open and standard network, server and storage equipment enables cost-effective choices versus the "black box" single-vendor approach of a DVR. And that's just looking at the hardware. Add lower installation costs and all the other benefits, and IP-Surveillance can save substantial sums for the end user.

7 Configuration Scenario Cost Comparisons

The following configuration scenarios and related cost comparisons do not represent the final analysis in terms of comparing these two competing technologies. They are presented here as general illustrations to help the end user consider how effectively—in terms of performance and cost—IP-Surveillance compares to the dominant DVR technology available today.

Scenario #1 New installation: 16 channels @ 2 fps, recorded for 15 days at CIF resolution. Solution requires 300 GB of storage. Storage demands can be reduced by using motion detection. All cameras are fixed indoor cameras. If outdoor and/or PTZ are used, the same additional costs would be added to both the DVR and IP-Surveillance scenarios.

	DVR	**IP-Surveillance**
Camera	$3,200 ($200 per camera)	$4,800 ($300 per camera)
Infrastructure (HW + installation)	$1,600 (Coax cabling)	$600 (Cat5) $700 (16-port switch)
Recording hardware	$ 7,000 (DVR)	$2,000 (PC Server)
Recording software	Included in DVR	$2,500 (NVR software)
Monitor, Keyboard	$1000	Included in PC
TOTAL	**$12,800**	**$10,600**
Per Camera Channel	$800	$662

Comparing both systems, the functionality is identical except for one important difference—the IP-Surveillance concept is much more scalable. If the IP-Surveillance end user wishes to add another channel, the cost will be $700 or so. While in the DVR scenario, one added channel requires an entire new DVR unit must be purchased at $7,000.

In many cases, all or most of the Cat 5 infrastructure is already in place, which would make this installation example even more favorable for the IP-Surveillance scenario.

Scenario #2 Installation with existing cameras: In many cases, analog cameras and coax infrastructure are already in place. In the case presented here, video servers can be used to digitize the video in the IP-Surveillance concept. Frames rates and recording is the same as described in Scenario #1.

	DVR	**IP-Surveillance**
Camera	Already installed	$5,200 (video servers)
Infrastructure (HW + installation)	Already installed	$100 (4-port switch)
Recording hardware	$7,000 (DVR)	$2,000 (PC Server)
Recording software	Included in DVR	$2,500 (NVR software)
Monitor	$2000	Included in PC
TOTAL	**$9,000**	**$9,800**
TOTAL per Camera Channel	$562	$588

Even though the IP-Surveillance scenario shows a slightly higher price, we should remember that this example shows the best-case scenario for the DVR solution, since it is 16 camera installation. If this were a 10 or 20 camera installation, the IP-Surveillance alternative will show a significant cost advantage.

Scenario #3 Enterprise-level installation: The larger the installation, and the higher level of performance desired, the more competitive—and impressive—the IP-Surveillance concept will be. In a high-end installation Axis completed in 2002, 300 network cameras were deployed in a high security area, with high frame rate recording. The total cost for installing the complete surveillance system was $800,000, or $2,700 per channel. If a similar functioning, DVR-based system had been deployed, the cost was estimated at $1.8 million, or $6,000 per channel—more than twice the cost of the IP-Surveillance system.

8 IP-Surveillance matures

Our comparison of performance advantages over the DVR demonstrates that IP-Surveillance is an attractive alternative at the present time. And, just as the progressive evolution of CCTV digitization has yielded improved system improvements over time, IP-Surveillance promises to deliver an ever-increasing host of future end user benefits:

- Increased intelligence located at the camera level, such as advanced Video Motion Detection (VMD), license plate recognition, object tracking, etc.
- Higher resolution than the limits of the analog NTSC and PAL formats; upwards to 0.5 Mpixel. Mega-pixel network cameras are already available, and soon they will be multi-megapixel.
- Power over Ethernet—eliminating the need to have power outlets at the camera locations and enabling easier application of UPSs (uninterrupted power supplies) to ensure 24/7 operations.
- Wireless transmission of video from some or all cameras, using cost-efficient standard technologies such as IEEE 802.11b (Wi-Fi), and wireless access of any video, live or recorded, via PDAs, Tablet PCs, and cellular phones.
- Encryption, watermarking, and connection authentication at the camera level, offering a significantly more secure solution than any analog camera

According to “Moore’s Law,” which governs the digital world, costs will continue to go down while capacity and performance increase. Soon, there will be more bandwidth, bigger hard drives, and cheaper and faster processors powering deeper digital penetration and market growth for the IP-Surveillance solution. Further accelerating this trend and the many end user benefits is the IT business model combined with open standards, which continues to drive competition and innovation.

9 Conclusion: The Future is IP-Surveillance

IP-Surveillance has been rapidly taking over the high-end range of the security and surveillance market. It has also started to effectively penetrate mid and low-range market segments as awareness grows, costs come down, and users implement more sophisticated cost-benefit analyses.

A new technology has meant a roster of new players: Cisco for switches, IBM or HP for storage and servers, and Axis for cameras. As this technology matures and gains widespread acceptance, there is a move to the "IT best-of-breed market approach," where vendors focus on one part of the solution while establishing a partner "ecosystem" to provide customers with a total solution—from equipment and software, to systems integration and support. In this way, the security and surveillance market is developing similar to the PC market, where Intel supplies the processors, Microsoft the operating system, IBM the hardware, and so on.

With this market structure in mind, when selecting a network camera manufacturer, the end user should consider the following four criteria:

(1) **Depth of experience.** Does the maker focus on the IP network video market? How many years of experience in the market?

(2) **Product range and standards.** How broad is the manufacturer's product range? Do the products comply with generally accepted non-proprietary standards, such JPEG and MPEG?

(3) **Business model and partner ecosystem.** Does the company work in a "best of breed" business model? How wide is the range of application software that is compatible with the products? Do the products comply to open standards, with open APIs? What partnerships does the manufacturer have with the other players, including application software, networking infrastructure, and storage vendors?

(4) **Proven market success.** Does the company have a large install base, proving they have the experience necessary to deliver and manage complicated, sophisticated technology? What are the number and quality of the reference installs?

In the evolution of CCTV systems, we've seen that, contrary to some popular opinion, the DVR is not an end point solution, but rather one milestone in the continuing development of CCTV technology. IP-Surveillance technology has equalled and surpassed DVR technology. There is a huge difference between the two technologies and the marketplace is only just beginning to understand this critical point.

In terms of performance advantages and cost comparisons, this paper has demonstrated that important and compelling advantages reside with IP-Surveillance technology. It is the security and surveillance technology for today and for the future. If you want to be part of the next great security technology wave, IP-Surveillance is in your future.

10 About Axis

Axis increases the value of network solutions. The company is an innovative market leader in network video and print servers. Axis' products and solutions are focused on applications such as security surveillance, remote monitoring and document management. The products are based on in-house developed chip technology, which is also sold to third parties.

Axis was founded in 1984 and is listed on the Stockholmsbörsen (XSSE:AXIS). Axis operates globally with offices in 14 countries and in cooperation with distributors, system integrators and OEM partners in 70 countries. Markets outside Sweden account for more than 95 % of sales.

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