WHITE PAPER

Video encoders

Providing analog video with IP benefits

March 2021

AXIS COMMUNICATIONS

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1 Introduction

Network video has revolutionized video surveillance in many ways. IP-based video surveillance systems provide lots of valuable benefits, such as vastly improved image quality, better scalability, event management, efficient video analytics tools, and – in many cases – lower cost of ownership. For various reasons, however, there is still an abundance of analog cameras and cabling out there, today and for several years to come.

The technology shift from analog to IP does not force security managers to immediately choose between an IP surveillance system and an analog video surveillance system. In fact, it is possible to successfully combine the two, thereby not only making it possible to maintain existing investments, but also reap many benefits of IP-based technology and create a future-proof platform. The solution is video encoders.

This white paper presents the basics of video encoders, how to use them, and what benefits they can provide to video surveillance. The last chapter outlines the evolution of video surveillance systems, from completely analog setups to true network video.

2 The easy path to network video

A video encoder functions as a bridge between an analog CCTV system and a network video system, thereby prolonging the operability of legacy systems. Simply put, encoders contain an encoding chip and an operating system that convert incoming analog video into digital video. The digitized signal can then be transmitted over the network to be recorded, for easier accessibility and viewing. Furthermore, encoders provide analog CCTV camera systems with many features and functionalities otherwise only associated with IP-based systems, such as tampering alarm and audio detection.

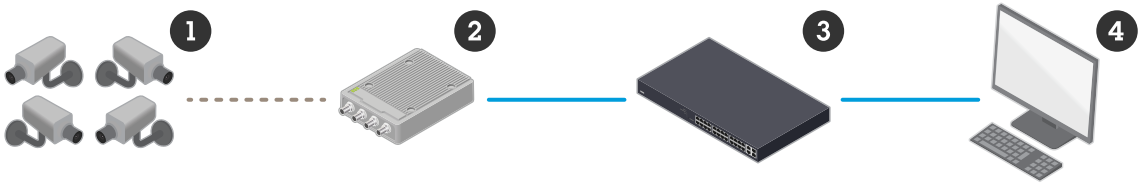

Figure 1. Analog cameras (1) can use legacy coaxial cabling to connect with a video encoder (2). The video encoder digitizes the video and sends it over LAN to a network switch (3) which can pass it on to video management software (VMS) (4).

The industrial rationale for video encoders is strong, since there are millions of analog surveillance cameras in use in the world. But for some operators, what's more important is the investment they have made in coaxial cable installations. In buildings without a network infrastructure, adding a modern network can be an investment that the owner wants to avoid – or at least postpone.

Video encoders are a key component in the market conversion from analog to network video surveillance systems. The market did see a similar, albeit more limited, technology shift when the digital video recorder (DVR) replaced the video cassette recorder (VCR). With DVRs, the need to change tapes was removed, image quality became more consistent, and finding exact video sequences in stored material became less laborious.

DVRs were eventually connected to the network, allowing remote video monitoring and operation, but nevertheless, they suffer from inherent disadvantages compared to a full-fledged network video system. With network DVRs, video is still stored on proprietary equipment, which provides a challenge when integrating with the fast-growing market of software applications for network and video management. DVRs also offer limited scalability.

2.1 How does it work?

A video encoder converts and compresses analog video signals into a video stream that is identical to that coming from a network camera, allowing it to be fully integrated into a network video system. The encoder sends the video stream over an IP network through a network switch to a PC server, which runs video management software for monitoring and recording. This is a true network video system because the video is sent continuously over an IP network. Users can view live video on a local or remote computer, or on a wireless device, such as a mobile phone or a tablet.

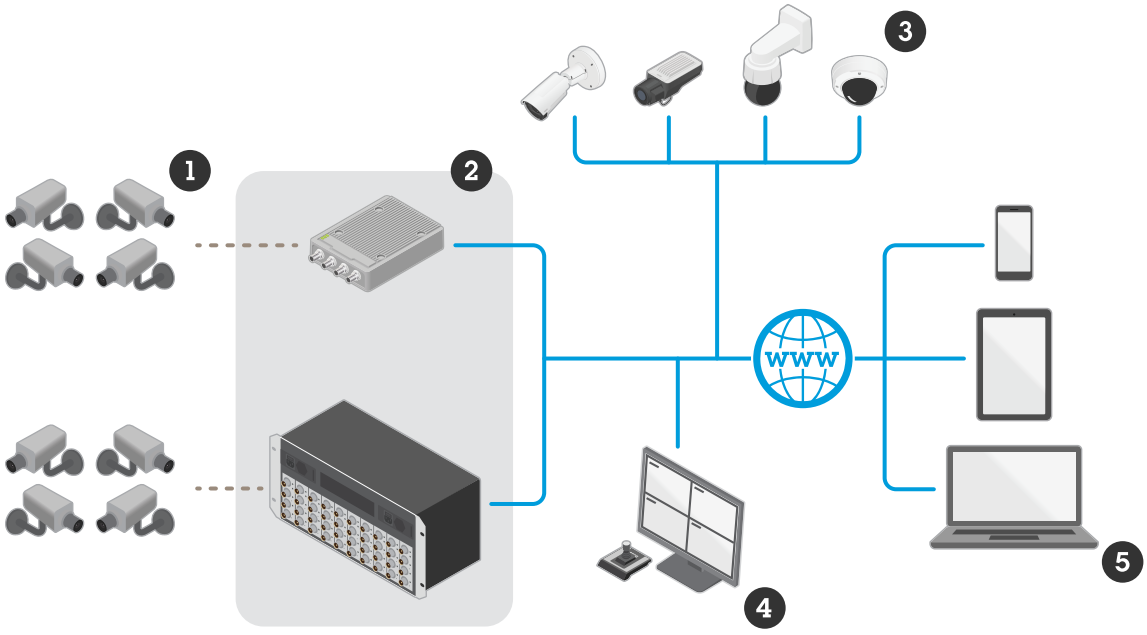

Figure 2. Video encoders (2) provide a solution for integrating analog cameras (1) with a network video system. This consists of network cameras (3), computers with VMS (4), and remote access from laptops or wireless devices (5).

2.2 IP benefits with encoders

Apart from the clear benefit, compared to a completely analog system, of remote monitoring and recording of video, high-end video encoders provide the surveillance system with lots of IP benefits.

2.2.1 Digital image quality

Digital images, unlike their analog counterparts, retain their quality regardless of the distance travelled. Video encoders also provide image fine-tuning, as well as aspect ratio correction which ensures that images are not distorted when viewed on a PC screen. High-performance video encoders provide full frame rate (30 fps in NTSC, 25 fps in PAL) in all resolutions for all video channels. Some encoders even support HD analog cameras with 1080p resolution.

2.2.2 Video analytics

A video encoder can enable a multitude of advanced functionalities, such as distributed video motion detection, tampering alarm, event management, and integrated audio support.

2.2.3 Remote PTZ control

Many video encoders offer pan-tilt-zoom (PTZ) control that allows analog PTZ cameras to be controlled over the network using a computer mouse or joystick. Control commands are carried over the same cable as the video and are usually forwarded by the video encoder through its serial port to the PTZ camera.

2.2.4 Power over Ethernet

If the video encoder supports Power over Ethernet (PoE), it can receive power through the same cable used for data transmission. PoE can give substantial savings for the entire system because power cables can be excluded from the installation. In addition, if the server room is connected to an uninterruptible power supply, PoE enables the encoders to receive centralized backup power so they can continue to operate even in the event of a power failure.

2.2.5 Cybersecurity

When adding encoders, a networked DVR can be replaced with standard computer servers and monitors. Apart from other benefits of using standard equipment, it can usually be made more cybersecure with continuous security updates and virus protection, than a networked DVR.

Axis applies cybersecurity best practices. However, securing a network, its devices, and the services it supports requires active participation by the entire vendor supply chain, as well as the end-user organization. The user must, for example, maintain safe password practices, limit physical and digital access to the networked devices, and keep firmware and software updated with the latest security patches.

2.2.6 Scalability and flexibility

Adding new cameras, or moving cameras around, is very straightforward in an IP system. Since recording and management is based on standardized computer hardware, the operator has a multitude of vendors and providers to pick from whenever more storage is needed or if other parts of the infrastructure must be upgraded.

Unlike analog CCTV/DVR systems, network video surveillance is built on open and interoperable standards; video encoders use universally accepted compression standards such as Motion JPEG, H.264, or H.265, enabling great savings in bandwidth and storage. Using standards also means that operators avoid the risk of being stuck with a proprietary technology. And, it allows for integration with other systems, for instance IP-based building management systems or industrial and logistical solutions. The possibility to combine and integrate different systems gives great leverage to a surveillance investment based on network video. This is especially useful in enterprise installations where there may be a great number of functioning analog cameras.

Furthermore, video encoders create a more future-proof video surveillance system that allows users to also add network cameras and experience all the benefits of a network video system, including high resolution video with progressive scan, megapixel, and HDTV or 4K image quality.

2.2.7 Edge storage and cloud storage

Many encoders are equipped with a memory card slot which enables local storage of recordings (edge storage) on an SD (Secure Digital) memory card, or similar. This can be used as a complement to central storage or as a backup when the central system is not available. The system even allows missing video clips, due to network disruptions or central system maintenance, to later be retrieved from the camera/encoder and merged with the central storage, ensuring uninterrupted and complete video recordings.

Encoders may also support cloud storage, which eliminates the investment costs for storage hardware. Cloud storage is a high-security option, both from a physical security and a cybersecurity perspective, since servers are located in protected premises and there are rigorous systems in place for data protection and backup.

2.3 Types of video encoders

The most common video encoder is a standalone version with single or multi-channel connections to analog cameras. Standalone video encoders are often positioned close to the analog cameras and typically used in situations where a few analog cameras are located in a remote facility, or where the setup is at some distance from the central monitoring room.

Figure 3. Examples of standalone video encoders with single or multichannel connections to analog cameras.

For larger, centralized systems, high-density racks with encoder blades offer the most flexible solutions. The blades typically support four or six channels. Video encoder chassis can be fitted with a mix of video encoder blades and can accommodate up to 84 analog channels, providing a flexible and expandable solution for migrating large-scale analog installations to network video. With hot swapping, there is no need to power down the entire system when installing or removing the video encoder blades.

Figure 4. Examples of video encoder blades and chassis with up to 84 analog channels.

2.4 Migrating to IP with Axis video encoders

Like network cameras, a video encoder contains a built-in web server, an encoding chip, and an operating system. In other words, video encoders are advanced products, so you need to carefully evaluate your needs and compare technical specifications before deciding which video encoder to choose.

Axis has the most comprehensive line-up of video encoders, from basic traditional devices to advanced feature-packed models with I/O ports, serial data communication, audio, support for HD analog cameras, and powerful processors for analytics capabilities. Offering video encoders is part of a long-term commitment from Axis to provide future-proof, flexible, and scalable systems based on standard IT equipment. Video encoders form an integral part of our product portfolio and you can rest assured that we will provide product support for five whole years after each encoder's final date of sale.

Apart from previously mentioned advantages of IP, selected Axis video encoders benefit from Axis Zipstream technology which is a more effective implementation of the H.264 and H.265 compression standards. With Zipstream, you preserve all the important forensic detail in your surveillance video, while considerably lowering bandwidth and storage requirements.

Axis video encoders support video management software (VMS) from Axis and all major third-party application developers. Axis video encoders also feature AXIS Camera Application Platform (ACAP), which makes it possible to run applications directly on the camera, such as advanced video analytics and other functionalities developed by Axis and third-party developers.

3 The evolution of video surveillance systems

3.1 Analog video systems

3.1.1 VCR-based analog CCTV systems

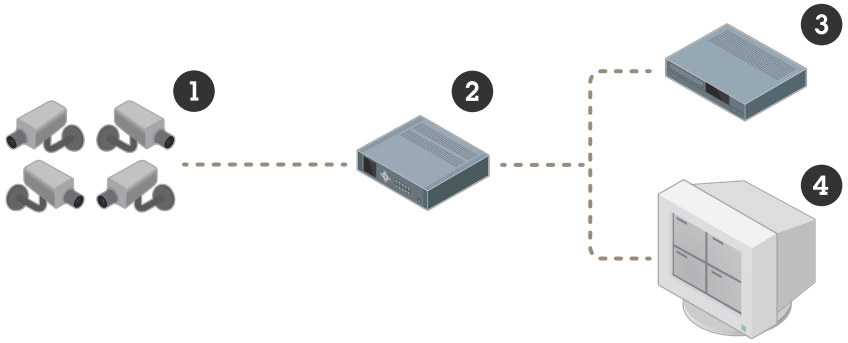

Figure 5. A traditional analog video surveillance system using analog cameras (1), a quad/multiplexer (2), VCR (3), and a monitor (4), all connected using analog coax cabling.

3.1.2 DVR-based analog CCTV systems

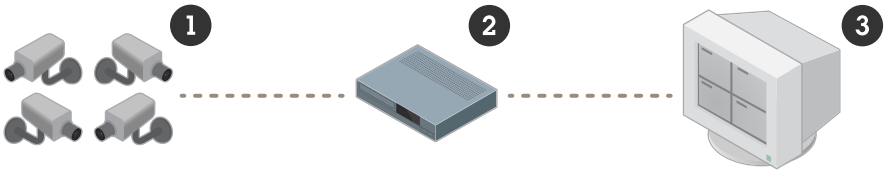

Figure 6. A surveillance system with analog cameras (1) that are connected to a DVR (2), which includes the quad or multiplexer functionality and provides digital recording.

The introduction of the DVR system provided the following major advantages compared to the VCR-based system:

- No tapes and tape changes
- Consistent recording quality
- Ability to quickly search through recorded video

3.2 Video systems combining analog and IP technology

3.2.1 Network DVR-based analog CCTV systems

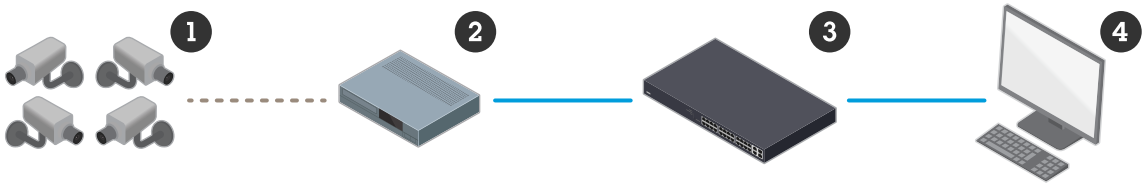

Figure 7. A system where analog cameras (1) are networked using a network DVR (2), a network switch, and a PC (4) for remote monitoring of live and recorded video.

The network DVR system provides the following advantages:

- Remote monitoring of video via a PC
- Remote operation of the system

3.2.2 Video encoder based network video systems

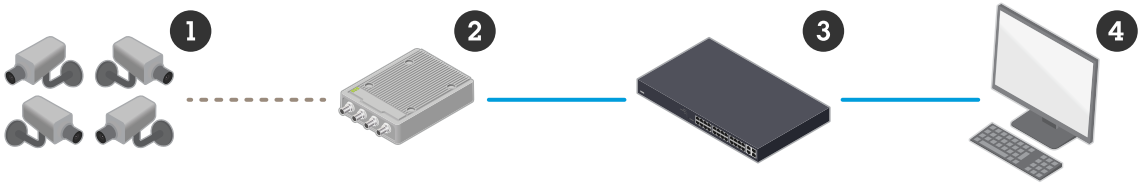

Figure 8. A network video system where video is continuously transported over an IP network. It uses a video encoder (2) as the cornerstone, along with a network switch (3) and a computer with a VMS (4), to migrate the analog security system into an open IP-based video solution.

A video encoder based network video system has the following advantages:

- Use of standard network and PC server hardware for video recording and management
- The system is scalable in steps of one camera at a time
- Possibility to record off-site
- Possibilities for advanced video analytics and other applications
- Easier to integrate with other systems such as Point of Sales and building management
- Ability to use Power over Ethernet
- Future-proof since the system can be easily expanded by incorporating IP cameras

3.2.3 Network camera based video systems using coaxial cables

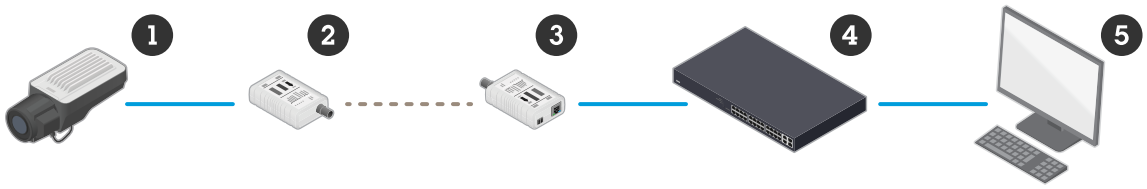

Figure 9. A network video system that utilizes a PoE+ over coax adapter kit (device adapter (2) and base adapter (3)) to combine IP cameras (1) and existing coax cabling. The system is connected to the network and to a VMS using a network switch (4) and a computer (5).

On sites with an existing infrastructure of coax cabling, you can use IP cameras together with Ethernet over coax adapters, which enable power and data to be sent through coax. This solution is suitable for small video systems that use few cameras and long-range coaxial cables. A network camera-based video system using coaxial cables provides the following advantages:

- No need for re-cabling, keep the coax
- Carries PoE and PoE+ over the coax cable
- Easy to install
- Reliable configuration

3.2.4 Network video system combining coaxial cabling with analog cameras and IP cameras

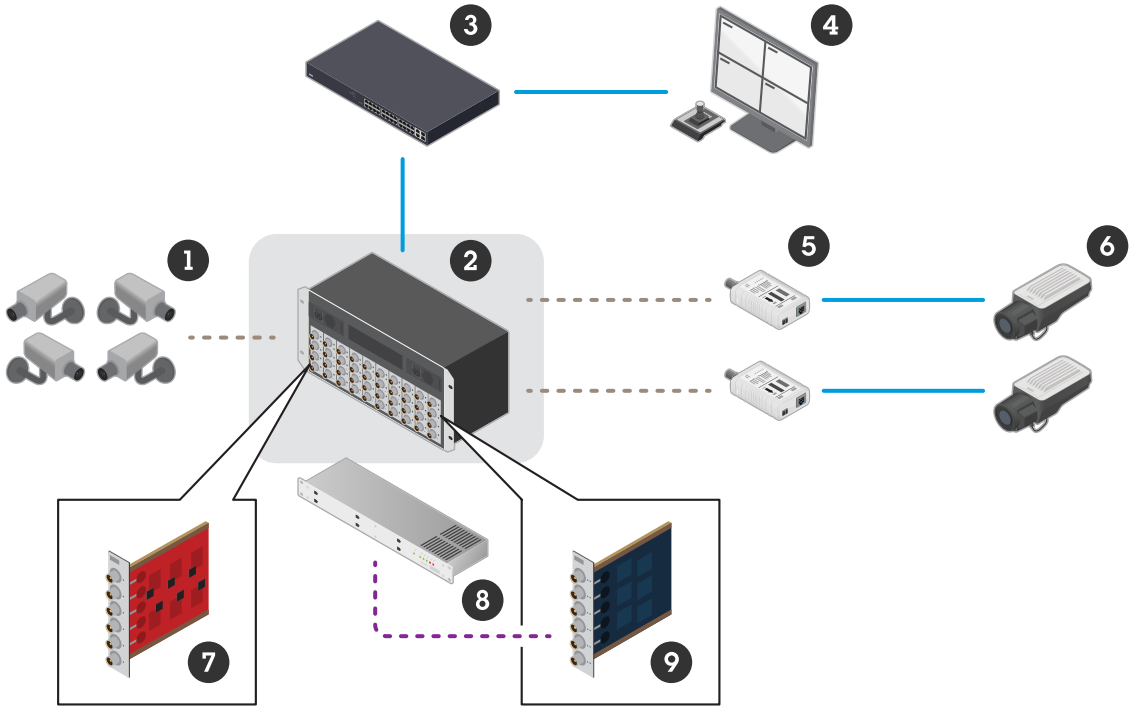

Figure 10. A network video system that utilizes existing coax cables and a video encoder chassis (2). A mix of video encoder blades (7) and Ethernet over coax adapter blades (9, receiving power from a power supply unit, 8)) is used in the chassis. Analog cameras (1), as well as network cameras (6) combined with

PoE+ over coax devices (5), provide video that is networked using the network switch (3) and connected to a computer with a VMS (4).

In some instances, it is neither practically nor economically justifiable to replace all existing coax cabling with Ethernet cabling. However, the coax cable can be used for IP cameras by utilizing Ethernet over coax adapters, which convert an analog system to digital. These adapters are available as single channel units as well as multi-channel blades and can be used in video encoder chassis. The multi-channel blades are typically used in larger installations where coax cabling is installed to a central location. A video encoder chassis can be used with video encoder blades and Ethernet over coax blades simultaneously, enabling a seamless migration to network cameras. A network video system that combines coaxial cabling with both analog cameras and IP cameras provides the following advantages:

- No need for re-cabling, keep the coax
- Re-use of existing video encoder chassis
- Carries PoE and PoE+ over the coax cable
- Easy to install
- Reliable configuration
- Seamless migration – analog and network cameras can be combined

3.3 Network video systems

3.3.1 Network camera based network video systems

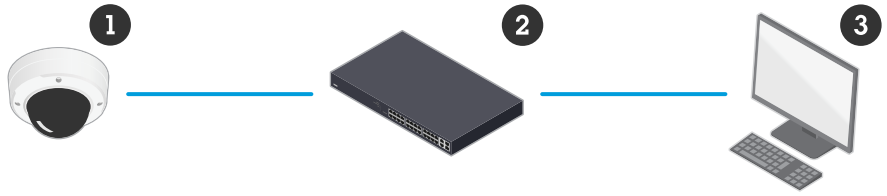

Figure 11. A true network video system where video from network cameras (1) is continuously transported over an IP network. This system takes full advantage of digital technology and provides consistent image quality from the cameras to the viewer at whatever location, enabled by a PoE switch (2) and a computer with a VMS (3).

A network camera-based network video system provides the following advantages:

- Ability to use high resolution (megapixel, HDTV, or 4K) cameras
- Consistent image quality, regardless of distance
- Ability to use Power over Ethernet and wireless functionality
- Full access to functionalities such as pan-tilt-zoom, audio, and digital inputs and outputs over IP, together with video
- Camera settings and system adjustments over IP
- Full flexibility and scalability

About Axis Communications

Axis enables a smarter and safer world by creating solutions for improving security and business performance. As a network technology company and industry leader, Axis offers solutions in video surveillance, access control, intercom, and audio systems. They are enhanced by intelligent analytics applications and supported by high-quality training.

Axis has around 4,000 dedicated employees in over 50 countries and collaborates with technology and system integration partners worldwide to deliver customer solutions. Axis was founded in 1984, and the headquarters are in Lund, Sweden