Application Note



Video networks with LineRunner SCADA NG: Ethernet networks and Video-over-IP in the industrial environment

Video networks or network video?

Why transmission technology plays a key role

Video cameras for monitoring traffic flows, building and process control in industry have been standard practice for decades.
The good-old analogue cameras are relatively simple devices compared with the options that today's digital cameras offer.

Planners and users of video-surveillance networks have powerful solutions to choose from nowadays. Apart from purely analogue transmission (e.g. with coaxial cable), modern systems have the whole world of digital transmission open to them.

There are currently two options which are ideal for video surveillance:

- 1. The hybrid system uses modern, analogue cameras and then encoders and decoders (CODECs). These devices accept one or more analogue signals and digitise them. This data is then usually forwarded via a network interface (Ethernet) to the surveillance hub.
- 2. Modern network cameras (IP cameras) operate digitally, starting with the lens. Today they offer huge benefits (e.g. low power consumption, complete image processing in the camera itself etc.) In this case, the path to the central is through the Ethernet interface.

Every company will now definitely have a data network. If modern video systems can use this network, in terms of costs this is a huge benefit. But what happens if the cameras are not located in a building (e.g. a department store), but scattered over a wide area (industrial plant, port)? This is where modern digital transmission technology comes in.

From analogue to digital image transmission

The use of video cameras in surveillance has been standard practice for decades. Traffic management, building and process surveillance in industry are just a few examples. Based on analogue TV technology, the cameras, memory technology and monitors have been continually enhanced. However, the transmission of the image signal from the cameras to the surveillance hub and to the picture storage facilities has not changed greatly. The relatively high transmission bandwidth required coaxial cables, converters for analogue optical transmission, or amplifier for large distances and the use of copper cable. Unfortunately the law of physics sets boundaries when several amplifiers are used. Each amplifier – even the cable itself – is a source of noise. In other words, picture noise increases with every unit used.

Key changes came about when picture digitisation near to the camera was introduced.

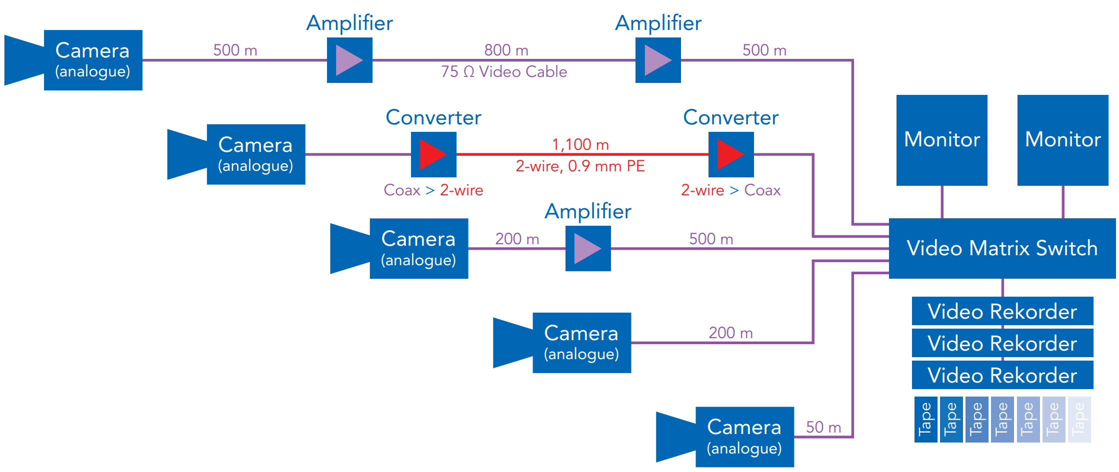

Figure: The traditional option - a typical analogue video network

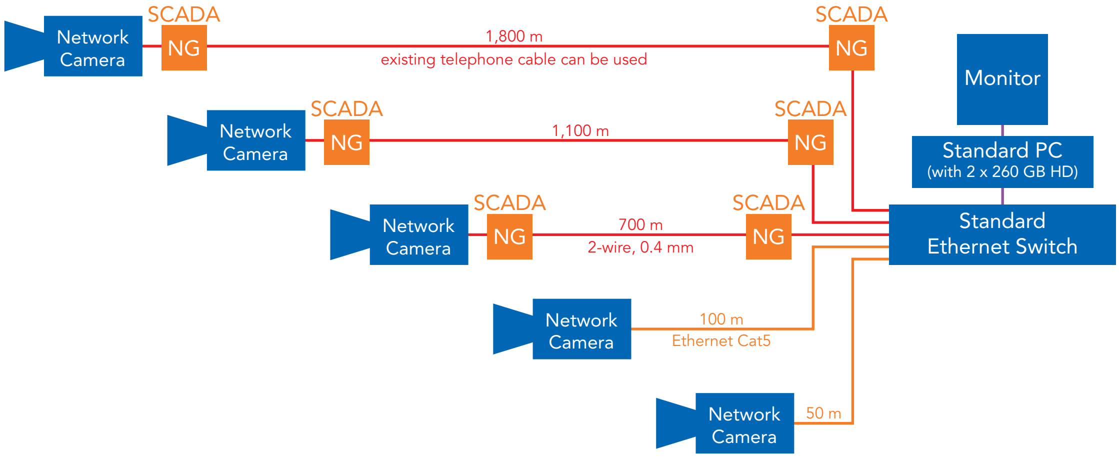

Figure: The digital solution - the same network with digital devices

In this case, the analogue video signal is converted into a stream of digital data. If standardised interfaces are then still used, the entire world of digital signal transmission is virtually open.

Since about 1999, the most flexible solutions are achievable with IP-network cameras. All image preparation and powerful data compression are integrated in the cameras themselves.

Nowadays, complex micro processor technology and temperature-resistant components make high-resolution cameras possible without sensitive, moving parts like the lens, adjustable focus and optical filters. Network cameras – as the name suggests – use a data network to transmit signals. This network can be a private (IP-based) network or the public Internet.

Digital data stream and interfaces

If the video data is available in digital form, data preparation and compression are then carried out. Afterwards, the data is processed for transmission in packets (Ethernet).

Today's network cameras with a resolution of 1024 x 768 pixels (XGA) produce a data stream of about 1.5 to 2 Mbps. This network load is of course – because of the data compression – primarily dependent on the image contents.

The data on the camera's Ethernet interface (or the CODECs) can easily be fed over a network (LAN). The infrastructure the network requires such as switches, routers and also cable connections (patch fields) are standard in the industry or already exist in the company's network.

If the distances between the cameras and the next (active) Ethernet device are less than 100 m, the cabling required is the same as for normal network technology. Cat.5e or Cat.6 cable is used in this case.

In modern IP cameras, Power-over-Ethernet (PoE) has huge advantages at the installation stage. With PoE, the camera is supplied with power by the Ethernet connecting cable. The camera does not need its own power supply cable or power unit (plug-in power unit). If we imagine what it is like fitting a camera at a height of 6 m in rainy or windy weather conditions, the fitter will definitely be grateful for each and every cable that does not need to be laid. PoE makes planning and implementation much easier. But if a camera is further than 100 m away, or no Ethernet cable can be used – what then?

In surveillance of public spaces, power supply to the components is the biggest problem and one which is too complicated for conventional technology to solve.

The following example makes this clear:

A crossing – without a public building as an installation site – is to be monitored by cameras. As the management team cannot use its own building to install the camera, an area has to be leased to fit the camera. Costs will also be incurred for knocking a hole in the wall for the power supply.

And finally, a meter has to be installed to make separate invoicing for the power supply possible. All in all, the expenditure is considerable and often more than the actual benefit achieved.

Power supply with PoE

In this case, PoE is ideal for energy supply. However, PoE only has limited capacity – a maximum of 12 W based on the currently used PoE standard. Work is currently being done to increase capacity. However, the capacity is enough to supply the market leader's cameras with power – however without the pivoting and tilting functions that are possible by remote control. To perform these functions, the actuators usually need about 20 W.

This means, above all in public places, tunnel systems or similar, that the expenditure for leasing walls and installing the power supply is considerably higher and more difficult than installing the camera and connecting it to the mains.

The transmission technology

Very few cables in telecontrol or telecommunications networks are Ethernet compatible.

The copper cable laid, with its twisted pair structure, is not suitable for directly transmitting the Ethernet signals.

In this case, transmission by SHDSL technology can help. SHDSL transmission systems are available from many manufacturers. If they have a suitable Ethernet interface, the digitised video data streams can be transmitted via any existing telecommunications cables.

Some 2 Mbps can be transmitted to up to 9 km via telecommunications cables on a copper wire twisted pair with today's SHDSL systems, if the wire is 0.8 mm or larger in diameter.
4 km are achieved if the diameter is 0.4 mm. LineRunner SCADA NG fulfils these demands in a particularly flexible way.

LineRunner SCADA NG was developed for complex industrial networks for fast data transmission. What makes it so special is the optional usage of two independent line interfaces. These line interfaces (LIs) are available for copper (SHDSL, one copper pair), fibre optics (mono-mode) or E1 (2 Mbps/G.703, symmetrical). A particular advantage is the option of using two different LI types, e.g. copper and fibre optics. As a result, media conversion is automatic.

Two Ethernet interfaces, as well as a serial RS-232 are available as user interfaces.
All interfaces are independent of one another and can be activated individually.

The way the SCADA NG is designed tallies with installation technology customary in the industry: SCADA NG, as well as all accessories can be fitted on the usual assembly rails or in 19" mechanics. Weatherproof outdoor housings are also offered.

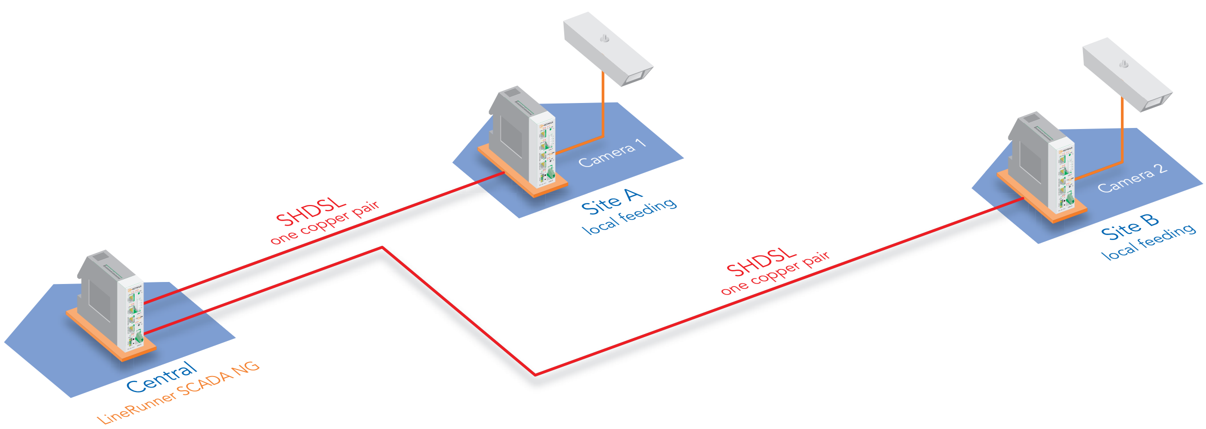

Figure: Two cameras are connected to the exchange via SHDSL (without redundancy)

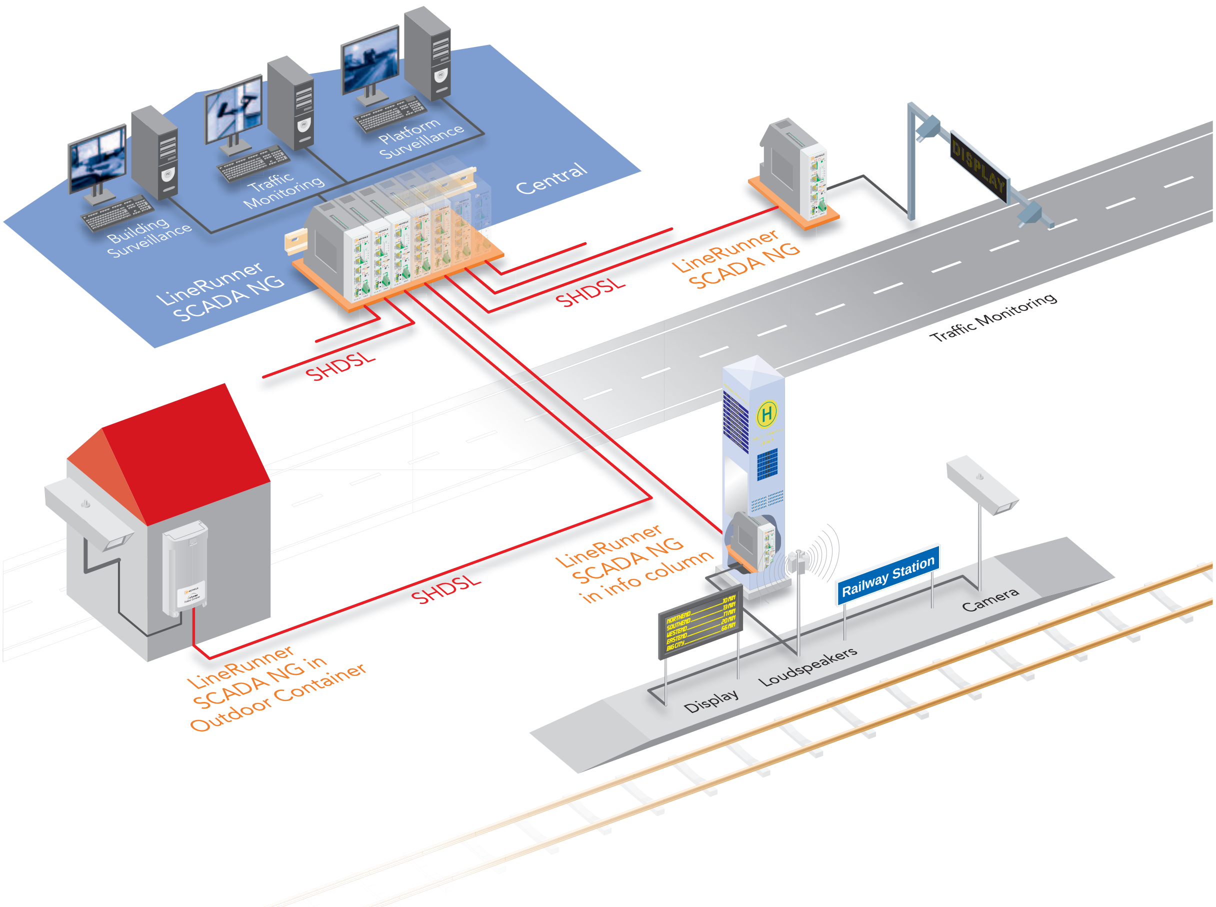

Figure: Video networks with LineRunner SCADA NG

The flexibility achieved with the two line interfaces means that virtually any network topology can be set up:

- Point-to-Point
- Chain formation (daisy chain)
- Ring routing (redundancy)
- Bridged taps

In terms of network technology, the SCADA NG acts like a transparent bridge (point-to-point) or – if n x SCADA NG is operated in a chain or ring – like a switch (layer 2) with n Ports (each SCADA NG would be a port). Each port can be 1, 10 or even 100 km apart. Thanks to internal data processing, each SCADA NG is a regenerator at the same time.

If the transmission path is set out like a ring, the whole transmission in the ring is protected from failure. Of course branch lines can also be set out in a ring.

Utility and railway companies often use SCADA NG for process and line control. In this case, the serial interface is often used.

When switching the technology to IP-based processes, just one of the Ethernet interfaces is used. In other words, nothing about the transmission infrastructure needs to be changed. If activated, the second Ethernet interface of a SCADA NG forms a completely separate network. Data streams from digital video cameras can be transmitted via this without any problems.

Any merging with other user data, or damage to critical telecontrol data is reliably prevented at the same time.

If a company's telephone network is converted to IP technology (Voice-over-IP, VoIP), transmission paths with SCADA NG can also transmit these data streams. An (active) VoIP telephone only creates network load of approx. 0.08 Mbps.

Public address and intercom systems with Ethernet interfaces are also customary today. The voice transmission quality achieved in these systems is almost HiFi-over-IP. Of course the important aspect in this case is the high clarity of speech required.

The applications

When we consider the opportunities that modern cameras, reliable transmission technology and VoIP offer, many more options open up. For example, gas pressure reduction stations, or a railway stop could be upgraded without laying new transmission lines with new surveillance and control functions.

When planning video surveillance systems a serious problem often emerges.

A network camera needs to be set up at an ideal location, but there is no secure power supply available. But access to a telecommunications cable is available.

Modern network cameras only have low capacity (approx. 3.5 W). The transmission device (SCADA NG) does need about 4.5 W. The (optional) remote supply units (LineRunner RFS/RPS) can feed the power supply required via the copper line for data exchange. Two copper wire pairs are used to carry this out. If a cable 0.8 in diameter is available, the distance to the exchange can be up to 6.5 km. If we remember that some network cameras still have an integrated VoIP telephone, remarkable possibilities emerge.

In this case, additional usage of PoE for easier camera installation is of course also possible.

Initially, the transmission bandwidth of 1, 2 or 4 Mbps might seem ridiculously small compared with gigabit Ethernet and 10 Gigabit Ethernet in corporate backbones.

However, the scenarios that SCADA NG was developed for are usually more than well served with this bandwidth.

Of course, if many data streams are bundled in one point, the transmission capacity to the exchange must be adapted accordingly. If for example 20 cameras are switched together at a central point, an estimated transmission bandwidth of 10 x 2 Mbps is required.

A 100 Mbps-path is advisable for transmission to the exchange.

An important aspect in commissioning, maintenance and live operation is the ability to access each element of the system for diagnosis or configuring purposes.

All LineRunner SCADA NGs are controlled by a powerful network management system. At the same time, the device can be integrated into a (possibly superior) SNMP-based system.

Cameras, SIP telephones and other IP-based devices include an entire web server. This means that each device can be contacted via a browser and configured or controlled.

Permanent background control is no problem with standard network surveillance programs.

Obviously even the best network management functions offer no protection from black spray paint or an axe, but intelligent cameras have an integrated memory with substantial capacity. Therefore, what happens before an attack is documented.

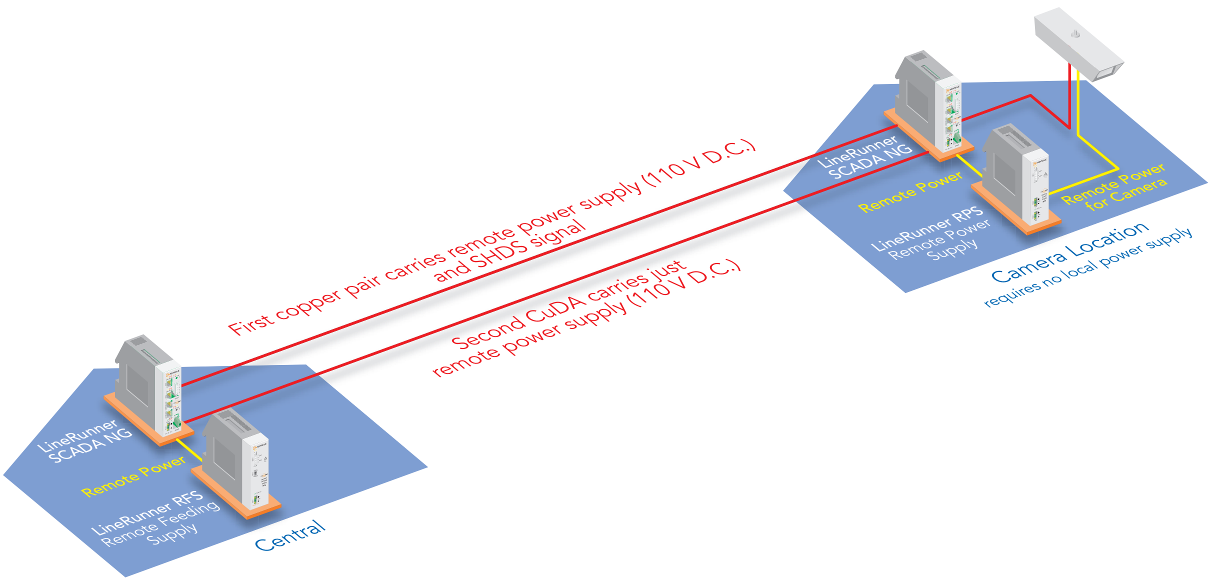

Figure: Operating a camera with two copper wire pairs (with remote power supply)

An example installation

The case of an electricity network operator is shown as an (albeit simple) example of a video installation with KEYMILE's LineRunner SCADA NG:

Cable drums containing valuable material are stored in an outside building yard. The yard is only checked once or twice a week. To prevent copper theft, a camera is to be fitted to a light pole. The camera is to be operated independently from the mains.
The telecommunications cable – the company's own cable laid in the ground – is 0.9 mm in diameter and is to be used for transmitting the signal. The distance (cable length) to the exchange is about 5 km. The telephone department can provide two wire pairs.

If required, it should be possible to monitor the area with a microphone. The picture produced by the monitor in the exchange should only appear if one of four possible movements occurs on the building yard (in the access road, gate, door and window buildings).
A loudspeaker should also be controllable.

The required video fields for reporting incidents were stored in the camera itself and trigger an alarm if the contents of the picture change in X seconds and by Y percent (separately adjustable for each field).

Because surveillance is also required in the dark, a double-eye camera with a colour-image sensor and a black and white sensor is used. Switching from one to the other sensor can for example be carried out automatically depending on the light.

Conclusion

Instead of complex installation with analogue video cameras, today surveillance functions are better served with IP-based technology. Thanks to numerous options for making transmission and storage of data redundant, this technology is much cheaper to install and offers much better availability than conventional surveillance systems. KEYMILE's Line Runner SCADA NG is ideal for data transmission in these systems. It also solves the power-supply problem and allows network operators and utility companies to use existing wire pairs effectively.

Publisher

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