ARTICLE

Top ten installation challenges

AXIS COMMUNICATIONS

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Introduction

A successful camera installation requires careful consideration of several things. What cameras should you choose? What is the best way to install them?

In this ten-step guide, we describe some of the challenges you can encounter during installation, and how to deal with them. We'll guide you through areas such as cabling, network setup, environmental considerations, and camera selection and placement, as well as how you can make the most of Axis camera image features.

1. Cabling Infrastructure

Poorly or incorrectly installed network cabling can cause numerous problems in your computer network. However small it may appear, a problem with network cabling can have a catastrophic effect on the operation of the network. Even a small kink in a cable can cause a camera to respond intermittently, and a poorly crimped connector may prevent Power over Ethernet (PoE) from functioning properly.

If there is existing cabling in an installation, an adapter can be used: the AXIS T8640 Ethernet over Coax Adaptor PoE+ is an ideal choice for installation of network cameras where coax cables are already present and may be very long or inaccessible. AXIS T8640 Ethernet over coax Adaptor PoE+ enables IP-communication over existing coax video cabling and converts an analog system to digital. With this adapter, the cabling can be 500 meters instead of 100 meters.

Considerations when cabling

Use the correct wiring standards
There are two wiring standards for network cabling: T568a and T568b. DO NOT COMBINE T568a and T568b on the same cable.

Use high-quality CAT 5e or CAT 6 cabling
Cables are categorized according to the data rates that they can transmit effectively. The specifications also describe the material, the connectors and the number of times each pair is twisted per meter. The most widely-installed category is CAT 5e. Ensure that the cabling in your installation fulfills the required Category (Cat).

- Cat 3 (no longer used) with 16 MHz bandwidth
- Cat 5e with 100 MHz bandwidth
- Cat 6 up to 250 MHz
- Cat 6A up to 500 MHz
- Cat 7 up to 600 MHZ
- Cat 7A with a frequency range through 1000 MHz

Video files are generally very large data files, and need to be moved around the network as quickly as possible. In general, it is possible to use good-quality Cat 5 cabling for gigabit networks; it is recommended to utilize Cat 5e or Cat 6 cabling for gigabit connectivity, even if your existing network switches and routers support only 100 Mbps. This will ensure that the cabling infrastructure is in place when the gigabit upgrade occurs. The rest of the points apply equally to 1 Gbps and 100 Mbps connections – each can be affected by poor cabling and incorrect connections.

Have good cable runs
Ensure that your cabling meets the requirements of your equipment. The distance between a transmitter and a receiver cannot be greater than 100 m (325 ft) in total. If installing sockets, remember to take into account the distance between the socket and the computer. A good rule of thumb is 90 meters for horizontal runs, and ten meters for the patch cabling.

Do NOT run cabling next to electrical mains cabling (because of the potential for interference), or suspend network cabling from ceiling tiles (this may violate building codes and fire regulations).

It is also mandatory to use an STP cable where the camera is used outdoors, or where the network cable is routed outdoors. Shielded Twisted Pair (STP) cabling needs to be grounded, and failure to do so can lead to interference problems. Use Unshielded Twisted Pair (UTP) cables if no high voltage or high Electric Magnetic Frequency (EMF) sources are located nearby. For more information about STP versus UTP, go to **www.axis.com/files/whitepaper/wp_network_cables_47113_en_1203_lo.pdf**

Since network cabling typically uses solid wire, cabling should not be twisted or bent into a tight radius (not less than 4 times the diameter of the cable). Do not use metal staples to secure cable runs, nor tightly adjusted cable wraps. Avoid a daisy chain network topology.

Use the correct connectors
Network connections use RJ45 connectors designed for either stranded or solid cable, but usually not both. Ensure that you use the correct crimping tool for the specific type of connector.

Keep the pairs together and wire correctly
A network cable consists of four pairs of twisted wires, and these are color coded (orange, green, blue and brown). The cable specification has been designed for high-speed data transfer and very little cross-talk. It is very important that no more than about 6 mm of the cable is untwisted at either end; otherwise, problems such as 'near end cross-talk' can arise, which will have a detrimental impact on your network. It is essential that you wire the plug correctly and not just from pins 1 through 8 at both ends.

Environmental conditions
Environmental considerations, for example whether the camera will be installed indoors or outdoors, determine the cabling and connectors to use.

Depending on the environment, the camera should be installed with the adequate housing to provide the correct level of protection. If the camera is exposed to acids, severe weather conditions, or extreme heat or cold, the camera needs a housing that withstands this kind of environment. For more information on Environmental issues, see Challenge 5, Environmental Considerations.

Certify the installation
In twisted-pair copper wire networks, copper cable certification is achieved through a thorough series of tests in accordance with standards set by the Telecommunications Industry Association (TIA) or the International Organization for Standardization (ISO). These tests are done using a certification testing tool, which provide "Pass" or "Fail" information.

Figure 1. A well-installed, well-structured cable enclosure using color-coded cabling makes for a much more professional appearance and also demonstrates adherence to specific standards.

2. Voltage transients

The most recognized cause of transient voltage is lightning; however, the most frequent source is the local power grid.

Axis network cameras for outdoor installation are protected by design against power surges and transients. Part of this design involves using a shielded network cable STP between the PSE (Power Sourcing Equipment)* and the camera to ensure a path for the power surge to reach ground.

The installation of Axis cameras using a shielded cable STP and a properly grounded PSE has been tested to comply with industry immunity standards levels, for example for surge protection. Any other installation method will void the warranty and leave the unit at risk.

Always use a shielded network cable STP between the camera and the PSE, and ensure that the PSE is properly grounded.

For further information, read: **Best practice for outdoor installation of Axis cameras**

** The term PSE defines any device connected at the camera end of the cable, such as a midspan, endspan, network switch, network hub or power injector.*

3. Power over Ethernet (PoE)

Power over Ethernet (PoE) is a mechanism for supplying power to network devices over the same cabling used to carry network traffic. PoE allows devices that require power, called Powered Devices (PDs), such as IP telephones, wireless Local Area Network (LAN) access points, and network cameras to receive both power and data over existing infrastructure without. No infrastructure upgrade is necessary.

This feature can simplify network installation and maintenance by using the switch as a central power source for other network devices. The challenge during installation is to calculate the total power consumption required so it is less than the power budget of the switch.

Calculate the total power needed

There are currently two standards for PoE. 802.3af allows for a maximum of 15.4 W per channel, whereas PoE 802.3at doubles the available power to 25 W.

The total power consumption requirement of all equipment that will be connected to a specific switch on a network needs to be calculated to ensure sufficient power is available per switch. This total wattage requirement must be less than a switch's PoE power budget – total PoE power per switch and per port.

The following chart shows the power consumption at both the PSE and the PD.

Class	Usage	Minimum Power Level Output at the Powe Sourcing Equipment (PSE)	Maximum Power Levels at the Powered Device (PD)
0	Default	15.4 W	0.44 – 12.95 W
1	Optional	4.0 W	0.44 – 3.84 W
2	Optional	7.0 W	3.84 – 6.49 W
3	Optional	15.4 W	6.49 – 12.95 W
4	Valid for 802.3at High PoE	30 W	12.95 – 25.5 W

Figure 2. Values to be used when calculating for the power budget of a system.

Figure 3. Example of power requirements in a PoE system.

As illustrated in Figure 3, six cameras, all PoE Class 2, are connected to one switch. Since a Class 2 device draws 7 W maximum from the switch, we can calculate the power requirements for a total of 6 cameras X 7 W = 42 W.

This will be the PoE power budget. Therefore, we need a switch with at least 42 W available for PoE.

Examples of xPoE and powering calculation with Axis cameras

The examples present the concept behind the PoE and powering calculation for an Axis camera. The exact figures and products used in the examples may change over time.

High PoE with AXIS Q6032-E
The AXIS Q6032-E power input is specified in the datasheet as max. 60 W and in the Installation Guide (IG) it is specified as 50 W (max.). However, the midspan AXIS T8124 input is specified as max. 74 W.

Why is the input 50 W/60 W for the camera, but 74 W for the midspan?

The background for this is that the midspan itself consumes power and there is loss of power in the RJ45 cable from the midspan to the camera. Therefore, to ensure proper power to the camera, the midspan needs input and output power that is higher than the camera needs.

To conclude: input to the midspan is 74 W, and output from the midspan is 60 W, while input to the camera is 50 W.

PoE with P13xx-E
Some cameras are specified with two different classes of PoE. This is because products can require different wattages, depending on whether they are used with or without extra equipment, such as heating or cooling. The first PoE number specifies the wattage for the product itself, whereas the second number specifies the wattage needed for the product, including extra equipment. The AXIS P13xx-E is an enclosed product, and is specified as "PoE IEEE 802.3af max. 12.95 W or High PoE max 25.5 W".

Using Direct Current (DC) Midspan
DC may be used for certain applications, such as solar panels, and AXIS has the T81B22 30W DC midspan for just this purpose. T81B22 is specified as "51 V DC at: 12 DC IN (max. 30 W) or 24 V DC IN (max. 15 W)".

PoE switch with P3384-VE
AXIS P3384-VE is specified as "Power over Ethernet IEEE 802.3af Class 3; max 12.1 W".

How can you find out what switch to use?

Usually the provider of the PoE switch describes three parameters that should be taken into account when deciding upon what switch to use. For example, the three parameters could be as follows:

> Supplies power to PD: up to 15,4 W
  This value is the maximum PoE power the switch can deliver per port, and is not related to total PoE budget. It is important to remember that it says "up to".

> Total PoE budget:
  The total PoE budget is what the switch can deliver in total PoE power on all ports. High value and few ports means a higher value of W per port. Low value and many ports mean a lower value of W per port.

> Average PoE W / port: 13
  Example: 50 W is the total PoE and the switch has 4 ports => 52 W / 4 = 13 W
  This value is basically what the switch per port can handle if all PoE ports are being used. It is important to have a margin here to be on the safe side to know my device.

Basically, in this example, an 802.3af PoE switch would be suitable for the camera, and can be used to connect four AXIS P3384-VE's.

Ensure the right PoE for environmental conditions

The PoE powering of a device becomes more critical depending on temperature. Many devices can function at different low temperature levels based on the amount of power available. It is imperative to verify the correct midspan is used for exterior cameras. As seen in the specification sheet below, the AXIS P1344-E can operate down to -40°C when using high PoE.

Power	**AXIS P1343/P1344/P1346/P1347:** 8-20 V DC or Power over Ethernet (PoE) IEEE 802.3af **AXIS P1343/P1344:** max. 6.4 W, PoE Class 2 **AXIS P1346:** max. 9.6 W, PoE Class 3 **AXIS P1347:** max. 9.0 W, PoE Class 3 **AXIS P1343-E/P1344-E/P1346-E/P1347-E:** PoE IEEE 802.3af max. 12.95 W or High PoE max 25.5 W
Connectors	RJ-45 10BASE-T/100BASE-TX PoE; 3.5 mm mic/line in, 3.5 mm line out; terminal blocks for power, 1 alarm input and 1 output
Edge storage	SD/SDHC/SDXC slot supporting memory card up to 64 GB (card not included) Support for recording to network share (network-attached storage or file server) - available in firmware version 5.40 and up
Operating conditions	**AXIS P1343/P1344/P1346/P1347:** Humidity 20 - 80% RH (noncondensing); 0 °C to 50 °C (32 °F to 122 °F) **AXIS P1343-E/P1344-E/P1346-E/P1347-E:** -30 °C to 50 °C (-22 °F to 122 °F) with PoE; down to -40 °C (-40 °F) with High PoE

Figure 4. Specification sheet for P1344-E.

4. Environmental

Surveillance cameras are often placed in environments that are very demanding. Failure to adequately protect an installed device from environmental factors can cause premature failure or void the product warranty. It may seem obvious that a camera placed outdoors might require a specific housing, but it may also be required inside an industrial facility with a high amount of moisture or dust in the air. Assessing and understanding the environmental conditions prior to installation is essential for selecting the correct cameras, and prolonging their lifespan.

Select the correct housing based on conditions
Camera housings come in various sizes and qualities, and various features. Housings are made of either metal or plastic and can be classified into two general types: fixed camera housings and dome camera housings.

When selecting an enclosure, several things need to be considered, including:

- Side or slide opening (for fixed camera housings)
- Mounting accessories
- Clear or smoked dome (for dome camera housings)
- Cable management
- Temperature and other ratings (consider the need for a heater, sunshield, fan and wipers)
- Power supply (12 V, 24 V, 110 V, etc.)
- Level of vandal resistance

For more information on housings, see the Axis Accessory Selector at
www.axis.com/products/video/accessories/configurator/index.php
or the Product Accessory page at **www.axis.com/products/video/accessories/index.htm**

Use the correct connector

The RJ-45 Push-pull Connector (IP66) which is shipped with the AXIS Q60-E and P55xx-E series of outdoor-ready PTZ dome cameras is required to be installed according to the instructions in the following document: **www.axis.com/files/manuals/connector_RJ45_39680_1206.pdf**

The customer can use the connector being shipped, or decide to order an optional premounted cable with the connector already attached, called the *RJ-45 IP66-rated Cable with premounted connector (CAT-6) 5 m.* This connector maintains the IP66 rating of the camera and prevents dust and moisture from entering into the dome assembly.

Ethernet cables can be run outdoors, but their thin plastic casing will deteriorate quickly when exposed to the elements. For best results, outdoor Ethernet cables should be placed in a conduit and buried a fair distance away from power lines or other sources of electrical interference. Remember to use an STP cable if the camera is used outdoors or if the network cable is routed outdoors.

PVC or other plastic pipe, installed with waterproofing, can work as a conduit. Special exterior or *direct burial* CATEGORY cables could be used for outdoor runs. Direct burial CAT5 cable costs more, but it is designed specifically for outdoor use. Both ordinary and direct burial CAT5 cables attract lighting strikes to some degree. Simply burying a cable underground does not lessen its affinity for lightning. Accordingly, CAT5 *surge protectors* should be installed as part of outdoor Ethernet networks to guard against lightning strikes.

Ingress Protection Rating (IP Rating)

The IP Code classifies and rates the degrees of protection provided against the intrusion of solid objects (including body parts like hands and fingers), dust, accidental contact, and water in mechanical casings.

Solid particle protection
The first digit indicates the level of protection that the enclosure provides against access to hazardous parts (for example, electrical conductors, moving parts) and the ingress of solid foreign objects.

Level	Object size protected against	Effective against
0	-	No protection against contact and ingress of objects
1	> 50 mm	Any large surface of the body, such as the back of a hand, but no protection against deliberate contact with a body part
2	> 12.5 mm	Fingers or similar objects
3	> 2.5 mm	Tools, thick wires, etc.
4	> 1 mm	Most wires, screws, etc.
5	Dust protected	Ingress of dust is not entirely prevented, but it must not enter in sufficient quantity to interfere with the satisfactory operation of the equipment; complete protection against contact
6	Dust tight	No ingress of dust; complete protection against contact

Liquid ingress protection

The second digit indicates the level of protection of the equipment inside the enclosure against harmful ingress of water.

Level	Protected against	Testing for	Details
0	Not protected	–	–
1	Dripping water	Dripping water (vertically falling drops) shall have no harmful effect.	Test duration: 10 minutes Water equivalent to 1mm rainfall per minute
2	Dripping water when tilted up to 15°	Vertically dripping water shall have no harmful effect when the enclosure is tilted at an angle up to 15° from its normal position.	Test duration: 10 minutes Water equivalent to 3mm rainfall per minute
3	Spraying water	Water falling as a spray at any angle up to 60° from the vertical shall have no harmful effect.	Test duration: 5 minutes Water volume: 0.7 liters per minute Pressure: 80–100 kPa
4	Splashing water	Water splashing against the enclosure from any direction shall have no harmful effect.	Test duration: 5 minutes Water volume: 10 liters per minute Pressure: 80–100 kPa
5	Water jets	Water projected by a nozzle (6.3mm) against enclosure from any direction shall have no harmful effects.	Test duration: at least 3 minutes Water volume: 12.5 liters per minute Pressure: 30 kPa at distance of 3m
6	Powerful water jets	Water projected in powerful jets (12.5mm nozzle) against the enclosure from any direction shall have no harmful effects.	Test duration: at least 3 minutes Water volume: 100 liters per minute Pressure: 100 kPa at distance of 3m
7	Immersion up to 1m	Ingress of water in harmful quantity shall not be possible when the enclosure is immersed in water under defined conditions of pressure and time (up to 1 m of submersion).	Test duration: 30 minutes Immersion at depth of 1m
8	Immersion beyond 1m	The equipment is suitable for continuous immersion in water under conditions which shall be specified by the manufacturer. Normally, this will mean that the equipment is hermetically sealed. However, with certain types of equipment, it can mean that water can enter but only in such a manner that it produces no harmful effects.	Test duration: continuous immersion in water Depth specified by manufacturer

5. Camera selection

For a successful installation, the selection of the correct camera is essential. There are a lot of things to consider: coverage area and angle, operational requirements – detection/recognition/identification, environmental constraints, and more. If the camera will operate in specific, tough conditions, or be put in difficult areas when it comes to light, such as extremely dark environments or in environments with high contrast between light and dark areas, this also has to be taken into account.

Guideline for selecting a network camera:

1. Define the surveillance goal: overview or high detail
   Overview images aim to view a scene in general or view the general movements of people. High detail images are important for identification of persons or objects (such as face or license plate recognition, point-of-sale monitoring). The surveillance goal will determine the field of view, the placement of the camera, and the type of camera/lens required.
2. Overt or covert surveillance
   This will help in selecting cameras, housings, and mounts that offer a non-discreet or discreet installation.
3. Coverage area
   For a given location, determine the number of interest areas, how much of these areas should be covered, and whether the areas are located relatively close to each other or spread far apart. The area will determine the type of camera and number of cameras required.

   An area may be covered by several fixed cameras or a few PTZ cameras. Consider that a PTZ camera with high optical zoom capabilities can provide high detail images and survey a large area. However, a PTZ camera may provide a brief view of one part of its area of coverage at a time, while a fixed camera will be able to provide full coverage of its area all the time. To make full use of the capabilities of a PTZ camera, an operator is required or an automatic tour needs to be set up.

   One of the unique benefits that network video brings to the video surveillance market is the ability to move beyond the traditional PAL/NTSC resolution and frame rate limitations, and experience high-resolution video with extreme image detail. HDTV, megapixel and standard resolution cameras have different application areas and benefits. For instance, if there are two, relatively small areas of interest that are close to each other, a megapixel or HDTV camera with a wide-angle lens can be used instead of two non-megapixel cameras.

4. Light sensitivity and lighting requirements
   Cameras with auto-iris lenses, such as a DC-iris or P-iris, are required for outdoor environments. In addition, consider the use of day and night cameras, due to their light sensitivity or whether additional lighting or specialized light from sources such as IR lamps is needed. Keep in mind that because there is no industry standard for measuring light sensitivity, lux measurements on network cameras are not comparable among different network video product vendors.
5. Image quality
   Image quality is one of the most important aspects of any camera, but it is difficult to quantify and measure it. The best way to determine image quality is to install various cameras and look at the resulting video images. If capturing moving objects is clearly a priority, it is important that the network camera uses progressive scan technology.
6. Resolution
   For applications that require detailed images, megapixel or HDTV cameras may be the best option.
7. Compression
   The three video compression standards offered in Axis network video products are H.264, MPEG-4 and Motion JPEG. H.264 is the latest standard and offers the greatest savings in bandwidth and storage.

8. Audio
   If audio is required, consider whether one-way or two-way audio is needed. Axis network cameras with audio support come with a built-in microphone and/or an input for an external microphone and a speaker or a line out for external speakers.
9. Event management and intelligent video
   Event management functionalities are often configured using a video management software program and are supported by input/output ports and intelligent video features in a network camera or video encoder. Making recordings based on event triggers from input ports and intelligent video features in a network video product provides savings in bandwidth and storage use, and allows operators to take care of more cameras since not all cameras require live monitoring unless an alarm/event takes place.
10. Networking functionalities
    Considerations include PoE, HTTPS encryption for encrypting video streams before they are sent over the network, IP address filtering, which gives or denies access rights to defined IP addresses, IEEE802.1X to control access to a network, IPv6, and wireless functionality.
11. Open interface and application software
    A network video product with an open interface enables better integration possibilities with other systems. It is also important that the product is supported by a good selection of application software, and management software that enable easy installation and upgrades of network video products. Axis products are supported by both in-house video management software and a wide variety of video management software solutions from more than 550 of its Application Development Partners.

    Another important consideration, outside of the network camera itself, is the selection of the network video product vendor. Since needs grow and change, the vendor should be seen as a partner, and a long-term one at that. This means that it is important to select a vendor that offers a full product line of network video products and accessories that can meet the needs now and well into the future. The vendor should also provide innovation, support, upgrades and product path for the long term.

    Once a decision has been made as to the required camera, it is a good idea to purchase one and test its quality before planning to order quantities of it.

Determining the coverage area

When selecting cameras, the field of view required should be defined. The field of view is determined by the focal length of the lens and the size of the image sensor; both are specified in a network camera's datasheet.

A lens' focal length is defined as the distance between the entrance lens (or a specific point in a complicated lens assembly) and the point where all the light rays converge to a point (normally the camera's image sensor). The longer the focal length of the lens, the narrower the field of view (FoV) will be.

The FoV can be classified into three types:

- **Normal view:** offering the same field of view as the human eye.
- **Telephoto:** a narrower field of view, providing, in general, finer details than a human eye can deliver. A telephoto lens is used when the surveillance object is either small or located far away from the camera. A telephoto lens generally has less light gathering capability than a normal lens.
- **Wide angle:** a larger field of view with less detail than in normal view. A wide-angle lens generally provides good depth of field and fair, low-light performance. Wide-angle lenses sometimes produce geometrical distortions such as the "fish-eye" effect.

Figure 5. Different fields of view: wide-angle view (at left); normal view (middle); telephoto (at right).

It is always advisable to take a snapshot from the camera to verify the coverage is correct and the depth of field is sufficient to capture the requirements. As depth of field changes with the available lighting, make certain to verify this multiple times per day.

Axis product selector

To assist in the selection process, Axis Communications offers a Product Selector Tool:
www.axis.com/products/video/selector/index.php

6. Advanced Image Features

When installing advanced network cameras, make sure all the camera's image capabilities are put to use.

Day and night functionality

All types of network cameras —fixed, fixed dome, PTZ, and PTZ dome — can offer day and night functionality. A day and night camera is designed to be used in outdoor installations or in indoor environments with poor lighting.

A day and night, color network camera delivers color images during the day. As light diminishes below a certain level, the camera can automatically switch to night mode to make use of near infrared (IR) light to deliver high-quality, black and white images.

Near-infrared light, which spans from 700 nanometers (nm) up to about 1000 nm, is beyond what the human eye can see, but most camera sensors can detect it and make use of it. During the day, a day and night camera uses an IR-cut filter. IR light is filtered out so that it does not distort the colors of images as the human eye sees them. When the camera is in night (black and white) mode, the IR cut filter is removed, allowing the camera's light sensitivity to reach down to 0.001 lux or lower.

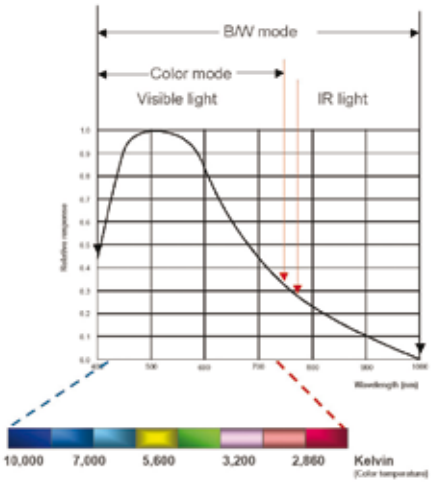

Figure 6. Graph illustrating how an image sensor responds to visible and near-IR light. Near-IR light spans the 700 nm to 1000 nm range.

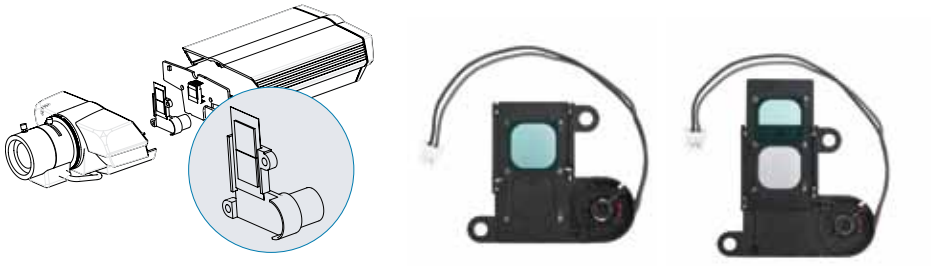

Figure 7. Image at left, IR cut filter in a day/night network camera; middle, position of IR-cut filter during daytime; at right, position of IR-cut filter during nighttime.

Day and night cameras are useful in environments that restrict the use of artificial light. They include low-light video surveillance situations, covert surveillance, and discreet applications, for example in a traffic surveillance situation where bright lights would disturb drivers at night.

Wide Dynamic Range (WDR)

Wide dynamic range is a feature that incorporates techniques for handling a wide range of lighting conditions in a scene.
In a scene with extremely bright and dark areas or in backlight situations where a person is in front of a bright window, a typical camera would produce an image where objects in the dark areas would hardly be visible. Wide dynamic range solves this by applying techniques such as using different exposures for different objects in a scene to enable objects in both bright and dark areas to be visible.

These types of scenes are typically encountered in the following scenes:

- *Entrance doors with daylight outside and a darker indoor environment*
- *Vehicles entering a parking garage or tunnel, also with daylight outside and low light levels indoors*
- *Vehicles with bright headlights, driving directly toward the camera*
- *Environments with lots of reflected light, for example, in office buildings with many windows or in shopping malls*

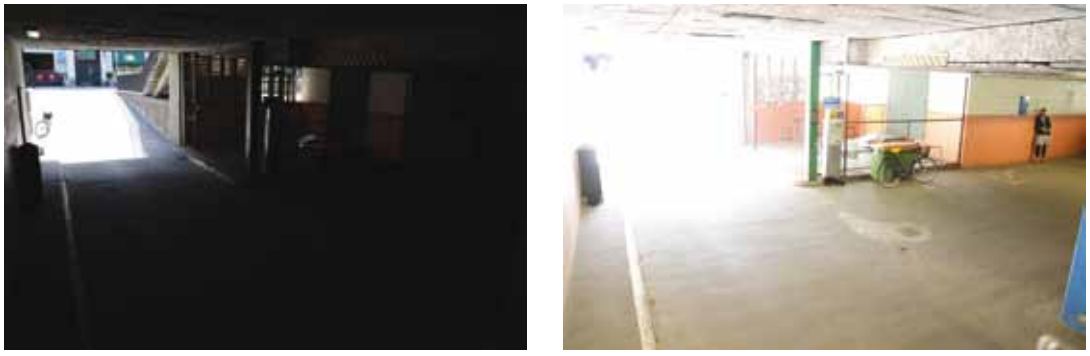

Figure 8. These comparisons show how detail can be lost when an image is over or under exposed due to the inability of a camera to provide WDR.

Figure 9. In this image, WDR – dynamic capture has been used, and it is clear how the image has been balanced to make all aspects in the view area visible.

Lightfinder

Axis Communications' research and development have led to the introduction of the new and revolutionary Lightfinder technology. The Lightfinder technology is the result of a meticulous choice of the right sensor and the right lens, together with the elaboration of the image data coming from the combination of sensor and lens. The fusion of these factors – sensor, lens, in-house chip development and knowledge in image processing – provides network cameras incorporating this technology with outstanding performance.

The Lightfinder technology makes AXIS Q1602 highly sensitive to low light, allowing the camera to "see" even in dark conditions. Axis' knowledge base about image processing, chip development, choice of

sensors and day/night lenses, has enabled the innovation of cameras maintaining focus during daylight and infrared light. Axis' knowledge heralds a new generation of surveillance cameras with outstanding performance. The fixed network camera delivers progressive scan image quality at D1 (720 x 576) resolution, in both indoor and outdoor applications, where light is poor.

The advanced Lightfinder technology will be especially beneficial in demanding video surveillance applications, such as construction sites, parking lots, perimeters and city scenes. In contrast to conventional day/night cameras that switch to black & white in darkness, AXIS Q1602 can maintain colors even in very dark conditions. There are many situations where surveillance video with color is an important factor for successful identification, and this capability greatly enhances the user's ability to effectively identify people, vehicles and incidents. In many cases, because of the camera's extreme light sensitivity, IR illuminators are not required, and this reduces installation costs.

Figure 10. Comparison between a standard network camera and an AXIS Q1602 camera in a low-light scene (0.3 lux).

7. Camera placement

When determining camera placement during installation, many factors must be taken into account. As mentioned in Camera Selection, the surveillance objectives decide *what* type of camera should be used, as well as *how* the camera should be placed.

Acquiring a useful image involves much more than simply pointing the camera at an object. Lighting, angle, reflections, dead zones, and the zoom factor for PTZ cameras are things to consider. Avoiding backlight and minimizing reflections are other factors that should be addressed. In some environments, in order to solve challenging scene problems, it's easier to change the environment itself.

Camera placement is also an important factor in deterring vandalism. By placing a camera out of reach on high walls or in the ceiling, many spur-of-the-moment attacks can be prevented. The downside may be the angle of view, which can be compensated for to some extent by selecting a different lens.

Camera purpose

The purpose of each camera should be clearly specified. If the aim is to get an overview of an area to be able to track the movement of people or objects, make sure that a camera suitable for the task is placed in a position that achieves the objective.

If the intention is to be able to identify a person or object, the camera must be positioned or focused in a way that will capture the level of detail needed for identification purposes. Local police authorities may also be able to provide guidelines on how best to position a camera.

Field of view

The fastest way to find out what focal length lens is required for a desired field of view is to use a rotating lens calculator or an online lens calculator. Both of these are available from Axis at:
www.axis.com/techsup/cam_servers/lens_calculators/index.htm

The size of a network camera's image sensor, typically 1/4 in, 1/3 in, ½ in and 2/3 in, must also be used in the calculation. The drawback of using a lens calculator is that it does not take into account any possible geometrical distortion of a lens.

The distance from the camera to the object
To calculate the distance, use Pythagorean Theorem: $a^2 + b^2 = c^2$

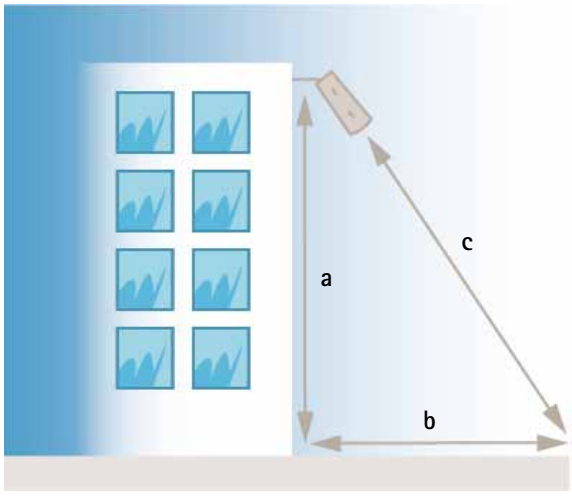

Figure 11. Pythagorean Theorem: $a^2 + b^2 = c^2$

Large area coverage with capture points
One camera will provide an overall view of the scene, but will probably not provide enough details for identifying people in the area. If this is one of the surveillance goals, then an additional camera needs to be included in the design (see Figure 11). Identification is now possible when a person enters a large area. The information about where and how many people are in the room can still be objectively obtained using an additional wide angle camera.

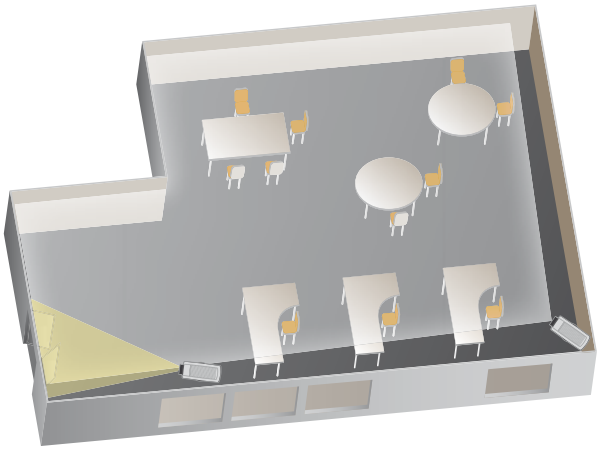

Figure 12. A room covered by two cameras; one camera covering the overview and one camera covering a capture point.

Light considerations

For successful camera placement, light considerations are crucial. It is normally easy and cost-effective to add bright lamps in both indoor and outdoor situations to provide the necessary light conditions for capturing good images.

When mounting cameras outdoors, it is important to consider how the sunlight will change during the day. It is also important to avoid direct sunlight, as it will "blind" the camera and can reduce the performance of the image sensor. If possible, position the camera with the sun shining from behind the camera.

Avoid backlight
The problem with backlight typically occurs when attempting to capture an object in front of a window. To avoid this problem, change the environment by repositioning the camera, or use curtains or plants or close blinds if possible. A carpet can also be used to minimize reflection in a situation like this, and reduce the amount of backlighting. If it is not possible to reposition the camera, add frontal lighting. Cameras with support for wide dynamic range are better at handling a backlight scenario.

Figure 13. In this scene, blinds and a plant have been used to solve the problem with backlight.

Directions of the sun
When mounting cameras outdoors, it is important to consider how the sunlight will change during the day. During part of the day (sunset), the crossed-out camera in Figure 13 would be looking in the direction of the sun.

If the exterior of a building is to be monitored, the location can be more or less affected by direct sunlight. Place the camera where sunlight has minimum impact.

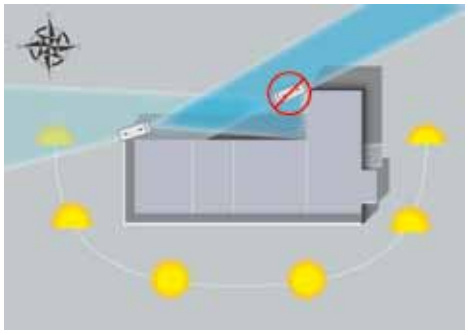

Figure 14. The sunlight will change during the day.

Camera angles

Detection zones and dead zones
The different ranges/zones of a camera are depicted in Figure 15 The line closest to the camera is where the maximum height is detectable. The yellow line illustrates the minimum required detectable height. The detection zone is in between these lines. These factors need to be addressed at the time of installation to ensure proper camera coverage.

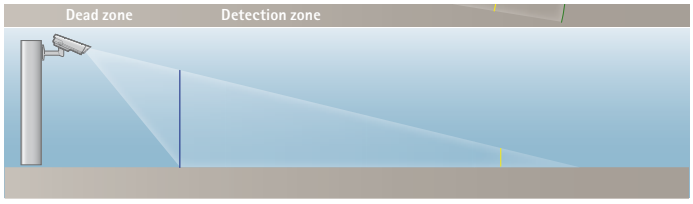

Figure 15. Be aware of the dead zones of a camera.

Field of view must be checked both horizontally and vertically. Often the planning is based on floor plans which give you only a top view of the area. The side view must also be considered to ensure desired coverage.

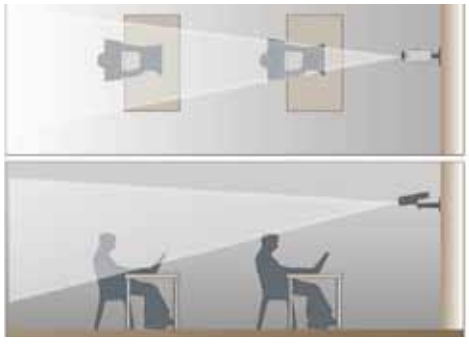

Figure 16. Remember to check the field of view both horizontally and vertically.

Camera to object angle
When placing cameras at doors or in lobby environments, care should be taken to avoid a high angle of view. As seen in the images, the larger the angle to the object, the more difficult facial features are to

recognize. As seen, 10-15° would give the best view for facial identification. On the other hand, placing a camera higher up puts it out of reach for vandals. It all goes back to the surveillance goals – is identification necessary?

Figure 17. The larger the angle to the object, the more difficult facial features are to recognize.

8. Tools

Installation tools can include both hand and power tools, as well as diagnostic equipment needed to perform the installation successfully and efficiently.

Hardware

A standard selection of hand tools, such as screwdrivers, wrenches, hammer, cutters, and pliers can assist in the installation, as well as power tools such as drills, saws, and cutters. Other tools, such as measuring tools, levels and templates are also useful for a successful installation.

A sufficiently sturdy ladder of the correct height to ensure safe installation is also required, though a power lift may also be used. Diagnostics or installation displays can also make a much more efficient installation. For more information on AXIS T8414 Installation Display, see **www.axis.com/products/cam_t8414/index.htm**

These tutorials show the entire installation procedure, highlighting the important steps in detail. **www.axis.com/academy/installation_tutorials.htm**

Axis online design tools

Axis offers a variety of tools to assist you when designing, selecting or installing our products. You can take advantage of our free tools at **www.axis.com/tools/index.htm**

Considerations during installation

For a successful installation, ensure the following:

> The installer must ensure that he/she reads the included installation documentation.

> The proper screwdriver, Allen wrench, etc. should be used, so as not to damage the mounting hardware.

> The correct security tool should be used for vandal-resistant dome assemblies.

> Ensure that all transport and packaging materials are removed from the dome assembly. This is very important especially for PTZ cameras, which is often packaged with a foam insert to protect the camera during transport.

9. Documentation

When performing a camera installation, make sure to document the installation properly. This is not done for its own sake; there are many reasons for it. First of all, it is crucial for the user when it comes to future installations. Furthermore, it is a matter of security for the user to know vital safety and planning information, such as how the cables are wired. Proper documentation can also help to reduce customer calls.

All aspects of the physical installation should be documented during the actual installation process. This documentation should include, but not be limited, to the following:

- Physical network layout showing all cable locations and the cable and port numbering scheme
- Camera and server IP addresses
- As-built floor plan showing camera locations
- Camera parameter setup list

The documentation required by the end user can then be handed over at the proper time, allowing for the end user to verify the information and also make better use of the training provided prior to system startup.

10. End User Training

End user training is one of the most important final tasks for the completion of an installation. This step is required, not only to introduce users to new equipment but also to consolidate new processes and procedures which may have been introduced by the installation.

Training not only benefits the user, it benefits the integrator by reducing post-installation questions. It also allows end users to make much better decisions and use of the installed system.

The end user training will require documentation from the equipment manufacturer as well as integration technicians. All aspects of the system will need to be taught to the users. Various user groups might also require different training levels, from simple PTZ camera control and configuration to VMS recording and playback.

Figure 18. Training not only benefits the user, it benefits the integrator by reducing post-installation questions.

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About Axis Communications

As the market leader in network video, Axis is leading the way to a smarter, safer, more secure world – driving the shift from analog to digital video surveillance. Offering network video solutions for professional installations, Axis' products and solutions are based on an innovative, open technology platform.

Axis has more than 1,000 dedicated employees in 40 locations around the world and cooperates with partners covering 179 countries. Founded in 1984, Axis is a Sweden-based IT company listed on NASDAQ OMX Stockholm under the ticker AXIS. For more information about Axis, please visit our website www.axis.com.

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