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White Paper

How and Why to Select Megapixel, IP and Analog Security Cameras

A commonsense guide for chief security officers (CSOs), directors and managers on how to maximize the effectiveness of your surveillance solution by selecting the right combination of cameras for the task.

No matter the type of video software, transmission, storage and management, no matter what kind of application ranging from a school hallway to an airport check-in, the heart of the system sits at the edge. It's the camera.

Of course, there are analog and digital cameras. But there is more commonality than differences between them. In its first in a series of Infinova white papers, also available on the firm's Web site, the dilemma of when to move to IP was explored with a simple bottom line – jump in based on a cost-managed way that extends the life of existing equipment. For most sites, the migration will take place gradually; and, during the process, analog and IP solutions will coexist, in some cases for many years to come.

As before, let's follow CSO Terry Jones and Helena Smith, his second-in-command, who work for a mid-sized enterprise, as they now face the decisions and intricacies involved in selecting cameras.

Types of Cameras

Basically there are two general types of cameras: Fixed and pan-tilt-zoom (PTZ). There are also two types of camera technology: analog and IP or network cameras. Fixed cameras are not as complicated as PTZ models, which, on one hand, can simplify the selection process as well as migration. On the other hand, because fixed cameras have fewer features and adjustments, it's crucial to have or buy the right lens for a specific application with them.

Most installations use both fixed and PTZ cameras, depending on needs. On average, PTZ cameras cost more than fixed cameras. And because PTZ cameras generally are larger than fixed cameras, fixed cameras may appeal to end-users seeking aesthetics along with security. For example, there are fixed mini-dome cameras, measuring only a handful inches in diameter, for installations where appearance is a chief consideration. In comparison with traditional fixed cameras, the dome adds an extra level of protection from bumps and cleaning crews.

If a camera is outdoors, there are many options. One is use of a so-called day/night unit. When the camera senses that it is nighttime, there is a boost in sensitivity. And it switches to monochrome. Another option centers on thermal imaging, night vision and infrared cameras. Often this approach includes infrared illumination, which is achieved through LEDs installed inside the housing. When selecting IR illumination, one rule of thumb from the A&E folks is one foot per LED. The downside: If something gets too close to the camera, it can create a bright flash in the image.

Megapixel and High Definition

As compared to standard definition cameras, emerging are megapixel and high definition (HD) IP cameras -- the Cognac and brandy of cameras. Not all megapixel cameras are HD but all HD cameras are megapixel. High definition or HD cameras are megapixel cameras but also meet HDTV standards. As with so much in the security camera sector, it all depends on pixels – the number of them in this case.

In the early 2000s, a changing of the guard occurred in the electronics industry. Standard definition, which had been the de facto technology for many decades, was joined by high definition. Standard definition (SD) refers to a digital video signal at either 640 x 480 or 704 x 480 lines of resolution.

Typical Resolutions of Cameras

	Monochrome Cameras	Color Cameras
Low Resolution	380 - 420 Lines	330 Lines
High Resolution	570 Lines	470 Lines
HD 1.3 megapixel	960 Lines	960 Lines
HD 3.1 megapixel	536 Lines	1536 Lines

Megapixel network cameras for security surveillance and remote monitoring applications boast more resolution and, therefore, higher quality images. Megapixel units can range from 1.3 to 5 and higher. For most applications, the work horse is the 1.3 megapixel camera. There are more of these than any others installed. It's the cost effective hook – in addition to price, 1.3 megapixel cameras give 2x the horizontal view of a standard definition camera.

The very high megapixel cameras -- 7, 10, and 14 -- are aimed at special applications and are not intended for general surveillance. They require more bandwidth and more storage, and the higher resolutions often do not operate at high frame rates, 1-2 fps.

Advantages beyond Analog

Still, increasing the detail or the "to be monitored" area above analog capabilities is an advantage. The large image format enables the camera to capture greater detail or offer a wider field of view. Megapixel IP video is digital data that takes up bandwidth so bandwidth management is essential in designing a cost effective IP video system. Most IP cameras have built in bandwidth management, though.

There also are diminishing returns when megapixel camera images are viewed on most monitors. Maximum resolution of the monitor is what you see from the cameras. So with megapixel cameras the higher resolutions look the same. The true benefit of higher megapixel resolution is in use of digital zoom.

Comparison Table of Horizontal and Vertical Pixels

Camera	H Pixels	H Increase	V Pixels	H Gain%	MP	MP Gain%
SD	640		480	100%	307,200	100%
720p HDTV	1280	2x	720	200%	921,600	300%
1.3 MP	1280	2x	1024	200%	1,310,720	427%
2MP	1600	2.5x	1200	250%	1,920,000	625%
1080p HDTV	1920	3x	1080	300%	2,920,000	675%
3MP	2048	3.2x	1536	320%	3,073,600	1024%
5MP	2592	4x	1944	405%	5,038,848	1640%
11MP	4000	6.25x	2656	625%	10,624,000	3458%
16MP	4872	7.6x	3248	761%	15,824,256	5151%

Scanning

Cameras also can vary by type of scanning. IP cameras use progressive or noninterlaced scanning in which all the lines of each frame are drawn in sequence. In contrast analog cameras use interlacing where only the odd lines, then the even lines of each frame (each image now called a field), are drawn alternately. Circling back to the need for both analog and digital cameras to coexist, Terry has already reached an important conclusion. While, in the past, there were legitimate questions about the image quality digital delivered; today IP cameras offer image quality superior to that of analog cameras. One reason is progressive scan; end users gain a very clear picture when looking at a video a frame at a time.

Progressive Scan Advantages

- Higher vertical resolution than interlaced video with the same frame rate.
- Absence of visual artifacts associated with interlaced video of the same line rate, such as interline twitter.
- No necessity in intentional blurring (sometimes referred to as anti-aliasing) of video to reduce interline twitter and eye strain.
- Offers much better results for scaling to higher resolutions than equivalent interlaced video. Scaling works well with full frames, therefore interlaced video must be deinterlaced before it is scaled. Deinterlacing can result in severe "combing" artifacts.
- Frames have no interlace artifacts and can be used as still photos.

The one disadvantage of progressive scan is that it requires higher bandwidth than interlaced video that has the same frame size and vertical refresh rate.

There are cameras that, as a package of the camera, lens and motorized gear, can do more things than fixed versions. One example is pan, tilt and zoom or PTZ. There are myriad situations in which a PTZ camera – analog or megapixel -- is the only viable choice.

Pre-sets and Speed Moving Through Positions

An important factor Terry and his colleague consider when selecting PTZ cameras is the number of pre-set positions that can be preprogrammed into the camera. Pre-sets are a series of positions that a camera can be programmed to automatically go through during the course of a tour, shift or day to help ensure that a specific area is covered or when a video surveillance system is integrated with an alarm or access control system. The camera can be programmed to go to an appropriate pre-set position when a certain event occurs, for

example, when a door is opened.

How quickly the PTZ camera changes positions is another consideration. For example, a camera may move up to 280 degrees per second when moving into a pre-set position but up to 100 degrees per second when security personnel or an officer controls the device manually. Speed domes, which have the ability to quickly move through a series of positions, are an alternative, especially when there are many points to monitor with a single camera or if the threat is particularly fast moving.

Fast pan speed is a strong feature of Infinova PTZ domes, with 400 degrees per second between presets points. In addition, in preset mode, positioning accuracy from one view to another is critical. Poor positioning accuracy results in a camera not pointing to the scene an operator selected for a stop on the tour. In regard to forensics, this can create useless evidence when suspicious activity needs to be reviewed. Infinova cameras have a preset accuracy of 0.1 degrees.

Zoom also is a feature viewed by Terry and Helena but a consideration complicated by the fact that many cameras have an optical as well as a digital zoom. An optical zoom makes far objects appear closer by using a series of adjustments to an optical lens. Many cameras also have digital zoom: Instead of zooming manually through the optics, an operator can enlarge the pixels. But there is a limit to the latter in terms of blurry displays.

Helena has a solid warning to her boss. Magnifying pixels does not help make surveillance images more usable. Digital zoom is only useful as long as it is uncovering dark pixels collected by the camera. With megapixel cameras, they likely collect many more pixels than a standard security monitor can display, so an operator sees the image at less resolution than the camera. In such a situation, digital zoom can bring some more data to the monitor. But once further digital zooming does not add any more information; it just makes it more blurry.

A Manager's Checklist for Cameras

There are a number of questions that Terry and Helena decided needed answering when considering their current and future cameras. Some will be answered thanks to the expert help of a systems integrator, A&E consultant or product manufacturer.

Among the Basics:

• What do you want the cameras to see and what is the distance?

- What types of lenses are needed? Wide-angle, normal, telephoto? Can varifocal lenses be used?
- What resolution is needed for each camera?
- Are megapixel, high-resolution or high definition cameras needed? How about thermal?
- Can the video management system accommodate the features of the cameras?
- Are licenses required for the digital cameras?
- How many images per second are needed for each camera?
- What is the total number of cameras required? Fixed or pan-tilt-zoom (PTZ)?
- What types of cameras are needed: dome/mindome cameras? Bullet cameras? Enclosures? PTZs? Wall or ceiling mount?
- If PTZ cameras are needed, are operators available, or will the PTZs be set on an automated panning pattern? Or will the PTZs be digital so they can be zoomed or moved after a recording is made?
- Are cameras in a special environment requiring enclosures, such as explosion-proof housings?
- What type of ceiling and walls are available? (Dropped ceiling, hard ceiling and walls, drywall?)

Among the Areas to Cover:

- Are cameras needed outside?
- What areas do you want to cover outside? Entrances, parking lots, open spaces, fences?
- Do license plate numbers have to be read?
- Is there any illumination at night? Are infrared illuminators needed? Day/night cameras? Thermal cameras?
- Are dome cameras appropriate or enclosures for cameras?
- Are heaters or blowers needed due to weather conditions?
- What type of wire is needed from the cameras: coax, twisted pair, Cat 5e, fiber-optic? Is it already installed?
- Can power over Ethernet (PoE) be used?
- Where are or will the power supplies located?

Housings and Enclosures

Dome cameras are a good choice for video surveillance systems to address either of two basic needs. When the installation requires the added power and flexibility of a pan/tilt/zoom camera, dome housing is necessary to enable the camera to have an unobstructed view no matter where it is looking. And some end-users see value in dome housing even when using a fixed camera for wall-mount or ceiling-mount applications because the dome can provide a more pleasing appearance. Of course, use of a dome, often smoked, means the bad guy doesn't know if the camera is pointing at him or not.

Whether PTZ or fixed domed cameras are part of a legacy installation or when buying new gear, security executives need

to consider the environment in which the camera will work. Some cameras have vandal-resistant and ruggedized domes, which can be important when a camera is mounted in an area that could be reached with a baseball bat or weapon. Other cameras may require a separate housing for vandal protection. Putting autotracking within a camera enclosure can speed reaction time as a PTZ dome camera follows a subject.

Special housings also may be needed if a camera will be installed outside. In certain climates, there is need for a heater and, for certain areas, need of a hidden blower. Sunshields also can play an essential role for some outdoor applications. Depending on an end-user's type of business or industry, housings that protect from water damage or dust are available as are housings with a pressurized seal.

What about the Lens?

The lens is the second most important choice in a security video system after the camera. One of the reasons lenses sometimes are taken for granted is that many video cameras, particularly popular dome cameras, come with a lens already built in.

Still, Helena has mentioned to Terry that both of them must clearly describe what exactly they want each camera to see.

To determine the right lens, the duo needs to consider how far away and how wide an angle each camera needs to see. So why consideration of a lens when some cameras come with one? Bitten before, Terry now knows that low-end solutions often include the camera and lens. But in crucial applications, more appropriate solutions include an integrator's selection of a lens for each camera based on the scene and lighting of the view.

There also is the issue of megapixel lenses for HD or megapixel cameras. Without the correct lens, a megapixel camera may not produce the high resolution images to match the capability of the camera's sensor. The lens bottom line: When selecting a megapixel lens make sure the megapixel resolution power extends across the lens's entire field of view, not just in the center. Some lenses, often lower priced, produce megapixel resolution only in the center of the lens; at the periphery, the resolution can be far less.

On the meeting room wall, Terry and Helena started answering some key questions:

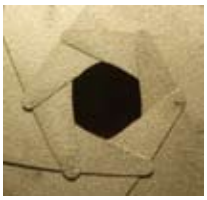
- What is the lighting in the installation area (indoor and outdoor)?
- Do you just want to see activity in an area or to specifically identify someone or something?
- How far away will the person/object to be identified be?

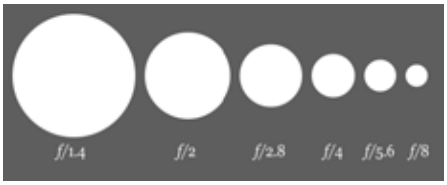
There are differences and situation advantages among fixed, varifocal and zoom lenses.

Fixed focal lenses have a single millimeter number and can be slightly less expensive than varifocal lenses, which have a range of settings, such as 2.6 – 6 mm (wide angle), 3.5 – 8 mm (medium angle), and 5 – 50 mm (long distance). Even though they cost a little more, varifocal lenses are flexible in most situation except where objects are a long distance away. Motorized zoom and telephoto lenses work with fixed cameras and, of course, PTZs. They have longer reach to hone in on a specific of the total image and often are used for specialty scenes and applications. End-users, including Terry and Helena, often have standardized on varifocal lenses for their fixed cameras.

Aspherical, Standard Lens; Manual, Auto Iris

Aspherical lenses – high end but not necessarily high priced -- have highly polished, computer-designed convex surfaces that let in more light than standard lenses and hold image focus better from center to edge. The technology is smaller in size, can correct for color aberration and lowers the lens f-stop number for increased light transmission. The iris in a lens is like the iris in the human eye; it opens and closes in response to light. Irises in manual iris lenses are set to one fixed f-stop opening and are best where lighting is relatively constant. Auto iris lenses have an electronically controlled iris that opens and closes as the light changes to maintain a constant video level image.





Focal Length – Camera and Lens Together

Focal length, measured in millimeters, is the distance from the center of a lens to the sensor. The longer the focal length, the narrower is the angle of view; the shorter the focal length, the wider the angle of view. To calculate the field of view or lens focal length of a security video camera, Terry and Helena must know some parameters of the installation. Among those parameters:

- Distance from Camera - Maximum distance from camera to the target.
- Camera Installation Height.
- Field of View – Height.
- Field of View: Width.
- Camera Sensor Format.

Lighting

Lighting also can impact the type and placement of security video cameras. No doubt, in the out of doors, day/night cameras have a role to play. Still, there are unique lighting issues related to megapixel cameras. For example, when it comes to obtaining full resolution for higher-rated megapixel cameras, without greater levels of lighting than what is naturally in a scene, the camera will not deliver the optimum resolution.

When it comes to lux lighting levels, they usually refer to the light at the sensor, not the ambient lighting in any given scene.

Frame rate also affects low light performance. The longer the exposure, the better the image a sensor can produce in low light. But there is a tradeoff when it comes to moving images. Helena has suggested to Terry that they go beyond some marketing brochures that show only scenes with no motion when stating low light performance.

By the way, frame rate is also an issue with megapixel cameras. Many of these cameras can only deliver 12-15 frames per second. This may prove insufficient for situations involving small, rapid movements such as dealers dealing cards at a casino table or money counting in the backroom at a bank.

Cameras with Intelligence

The degree of intelligence within video surveillance cameras varies. Some IP cameras provide intelligent motion detection, in which motion in certain areas can be noted while motion in other areas can be ignored. Some handle camera tamper alerting and video masking, in which only certain areas of the picture are shown.

Image cropping, people counting, object tracking, tampering detection and exposure modification of portions of a video picture also are possible. Some surveillance cameras include metadata about what is shown in the video, provide the time and date when the video was recorded, and perform facial and license plate recognition, to name a few.

Of course, how smart a camera has to be is a function of each individual application. Still, having intelligence in the camera – that is, at the edge – enables quick set up without heavy reliance on network resources. Cameras do not need to have expanded intelligence inside, however. Intelligence can also reside in encoders in the case of analogs, in storage devices and through analytics software in video management systems.

In-camera Storage and Command and Control

With the move to more features at the edge, storage has made a leap, too, right into the camera. Some cameras now boast inexpensive and handy SD memory cards. Overall, digital video and network video recorders continue to play an

end-of-the-image storage role, of course. In between, there are compression-decompression (codec) choices: MPEG-4 is about 50 percent more efficient than MJEG and H.264 is even more efficient, although H.264 may not work as well with megapixel cameras. By the way, most megapixel cameras employ MJPG, especially at the higher resolutions.

There also is a balancing act between codec used, processing power and storage needed. Overall, H.264 needs more processing power but needs less storage capacity. This is helpful when realizing that megapixel cameras – by their very nature – generate more data than lower resolution cameras.

Network Video Management Systems

At the command and control end, there are software-based video management systems (VMS) but, relative to cameras, the VMS must support all the features of the camera selected. Typically, brand leader VMS solutions may support only a sub-set of the features that are common to all megapixel or IP cameras.

Taking the Jump

There are cost implementations when moving from analog to network video as well as cost consequences when moving from IP video to megapixel and HD cameras. But the benefits are also clear. On Terry and Helen's office wall there are two simple equations.

- Camera Reduction = Cost Savings
- Increasing Resolution = Loss Prevention

While analog is less expensive in small installations with under 30 cameras, for example, a co-existence strategy of analog and digital cameras is a solid one. In addition, use of megapixel cameras can reduce the total number of cameras needed. An overview of this strategy is described in the first in this series of Infinova white papers.

That paper also covers the impact on infrastructure including trading cabling for CAT 5 or 6, sharing the enterprise data network, bandwidth and compressions and decompression schemes.

Infinova has a stable of technology that emphasizes the co-existence strategy which can gradually and intelligently jump from analog to IP video. There are analog fixed cameras and fixed minidomes, PTZ domes and PTZ cameras, and IR illuminated cameras. There are IP fixed cameras and fixed minidomes as well as PTZ domes and cameras.

In the next in the series of Infinova white papers, join Terry and Helena soon as they expand their decision to jump to IP video by connecting it all together through the use of fiber optic communications within security solutions.

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By helping channel partners provide their customers with complete, affordable, best-in-class, large and small video surveillance solutions, Infinova helps integrators generate more business more profitably. Leveraging a manufacturing process certified to ISO 9001:2000 standards and over 250 engineers with a list of video industry firsts, Infinova channel partners provide their end-users with industry-acknowledged product reliability and technical leadership.

So that Infinova channel partners can create complete solutions, Infinova provides IP surveillance cameras and components, CCTV analog cameras, DVRs and components, camera accessories, monitors, power supplies and fiber optics communications devices. Infinova also has the technical ability and manufacturing flexibility to let integrators propose customized solutions. In addition, Infinova will partner with other manufacturers making other surveillance equipment and software to help its channel partners create turnkey solutions. Contrary to most other companies, Infinova will back-up their partners' products as well as its own to assure both the integrator and its customers that one call – to Infinova only – takes care of everything.

Infinova works diligently to assure its channel partners can provide cost-conscious solutions. With Infinova's hybrid systems, channel partners can propose systems that protect a customer's investment in its already-installed analog surveillance system but that also put them on a dynamic migration pathway to IP systems.

Infinova is lauded for its exceptional maintenance programs. A major highlight is the company's 24-hour advanced replacement policy in which a substitute product is shipped immediately upon notice of a problem.

With such customer focus, Infinova is often referred to as "the integrators' manufacturer."

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