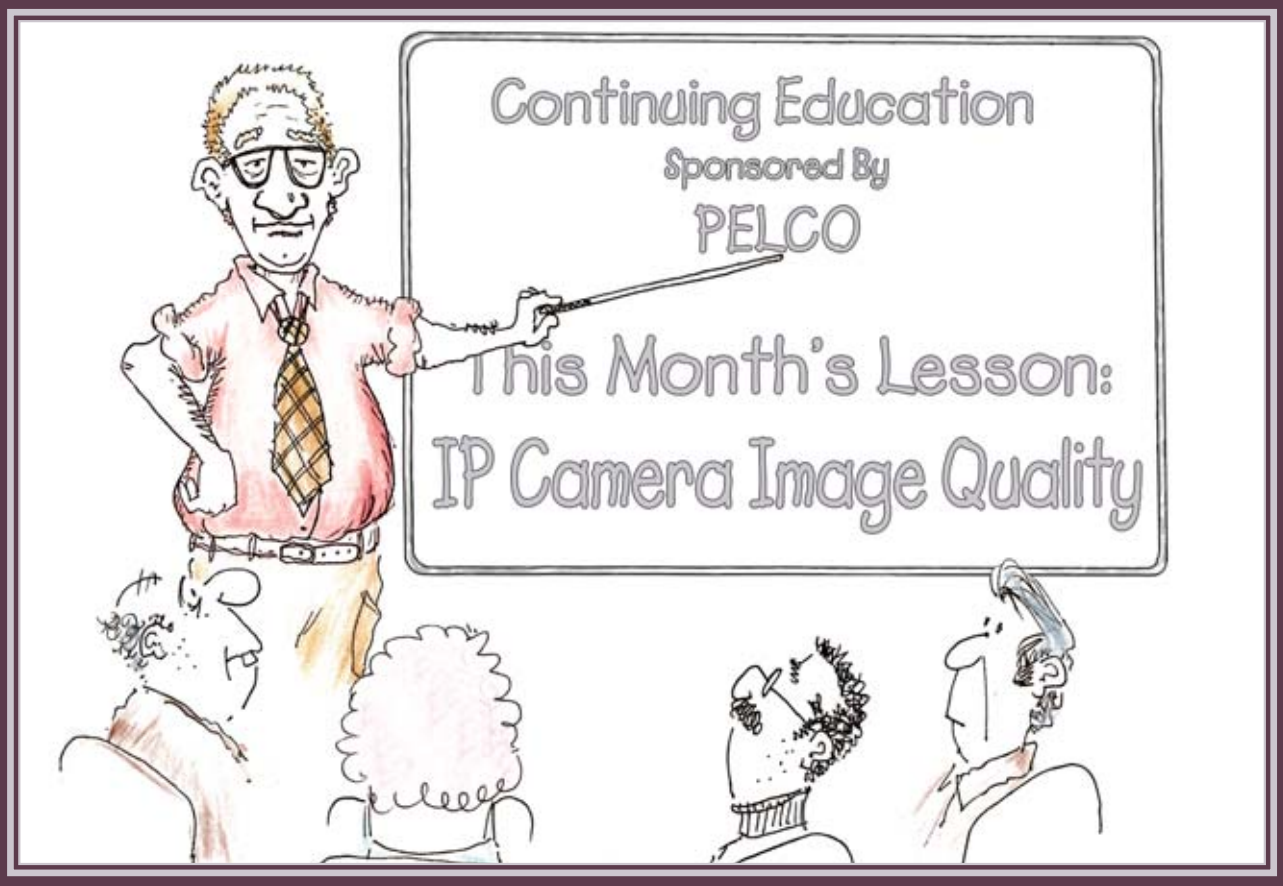

Understanding IP Video for DUMIES

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Part 2 of 4

Clear Eye for the IP Video Guy

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AT A GLANCE

- Image file size and bit rates affect system bandwidth requirements and the amount of storage required
- Lossless compression reduces file size with no loss in image quality, but compression ratios are generally weak; lossy compression discards information that can't be seen by the human eye
- Bit rate is defined as how much physical space an image occupies in 1 second on a network; the higher the bit rate, the more space required
- It is recommended when incorporating cameras and DVRs in the same system, the SNR should be at least 50dB or greater
- Blanking is a new feature appearing in IP cameras to help overcome some of the problems associated with movement

Whether a system is analog, hybrid or entirely IP-based, it's all for naught if the camera fails to capture quality images. While it's true many of the optimizing principles of older analog cameras apply to their IP successors, the technology introduces enough new wrinkles to keep even the most skilled integrators on their toes.

Welcome to the latest of *Security Sales & Integration*'s acclaimed "D.U.M.I.E.S." series: "Understanding IP Video for D.U.M.I.E.S." Brought to you by Pelco, this four-part series has been designed to educate readers about networked video — the next phase of surveillance technology following the quantum leap from analog to digital CCTV systems. "D.U.M.I.E.S." stands for dealers, users, managers, installers, engineers and salespeople.

In Part 1 of this year's series (*see "Using Camera Specs to Solve IP Application Issues" in the March issue*), we discussed the design of cameras, their specifications and how it relates to IP cameras as well as their networks. We also discussed how to determine the quality of cameras and whether they are designed for indoor or outdoor applications.

With IP video becoming a leading subject of many discussions, it is critical to understand the camera features that can help improve or hinder the overall performance of IP applications. That's why in this installment, we will delve into ways to enhance IP camera image quality, as well as address basic system layouts.

Before we can consider the functionality of different options or camera features, a basic understanding of IP camera features and layouts will be useful. This is due to the impact of image file sizes and transfer bit or data rates. The image file size as well as bit rates affect both the system bandwidth requirements and the amount of storage required for different applications. All of these parameters are an essential part of any IP camera or network design.

The Impact of Image File Sizes

Image file sizes, expressed in bytes, increase with the number of pixels in the image, and the color depth of the pixels. The more vertical rows of information, and the more horizontal pixels within those rows, the greater the image resolution; and the greater the activity within that image, the greater the file size. High-resolution cameras lead to larger image files. Files sizes may range from hundreds of kilobytes to many megabytes depending on the camera resolution and the compression methods used to transmit or store these images.

The larger your image file size, the more time it will take to transmit on a network and the greater the storage requirements. As an example, to calculate the size of one image of uncompressed video you need the following information:

Number of horizontal pixels (width)
Number of vertical rows (vertical)
Bit depth (8 bit, 16 bit, etc.)

Image file size = (pixel width X pixel rows X bit depth) /8* /1,024**

*8 represent an 8-bit byte

**1,024 equals the number of bytes per kilobyte

Let us calculate the file size of a 640 X 480 image with a 24-bit depth:

Image file size = (640 X 480 X 24
= 7,372,800 / 8
= 921,600 / 1,024
= 900k

Let's go one step further and determine the amount of storage for this example for just 1 second, which consists of 30 images per second:

One second of uncompressed video
= 900k x 30
Storage required = 27MB / second

This example surely explains the need for video compression. With video compression the overall file size will be reduced, allowing for less storage space as well as reduced system bandwidth. Compression methods will be the topic of discussion in Part 3 of this series. However, how can one reduce video file sizes? For many, the answer is simple; just increase the compression ratios of the IP cameras or the IP encoders. There are, however, other avenues supplied by the camera industry to improve this area.

There are two types of image file compression algorithms: lossy and lossless.

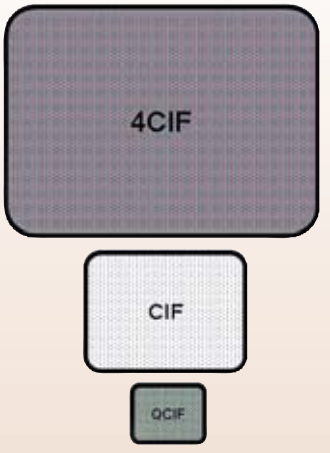
Lossless Vs. Lossy Compression

Lossless compression algorithms reduce file size with no loss in image quality, although compression ratios are generally weak. Most images destined for print, or when image quality is valued above file size, are compressed using lossless algorithms. File formats with an extension of .tiff or .gif are usually listed as lossless compression methods.

Lossy compression algorithms take advantage of the limitations of the human eye and discard information that cannot be seen. This irrelevant reduction is based on research by the HVS (Hunan Visual System). Most lossy compression algorithms allow for variable levels of quality (compression) and as these levels are decreased, file size is also reduced. At the highest compression levels, image deterioration becomes noticeable. File formats with an extension of .bmp, .jpg and .mpg are usually listed as lossy compression methods.

Common Intermediate Format (CIF) Pixel Counts

SQCIF (sub-quarter CIF)	128 X 96
QCIF (quarter CIF)	176 X 144
FCIF (full CIF)	352 X 288
4CIF (4 X CIF)	704 X 576
16CIF (16 X CIF)	1408 X 1152



CIF (Common Intermediate Format) is used to standardize the horizontal and vertical resolutions in pixels of video signals. It was designed to help convert NTSC and PAL signals.

Image Formats' Relation to Pixels

The first area that will improve image file sizes is the actual pixel size of the video image necessary to produce the required results in a surveillance IP system. The pixel size of an image is normally referred as the CIF (Common Intermediate Format) size.

CIF formats are defined by their resolution and standards, both above (2CIF / 4CIF) and below (QCIF / SQCIF) with CIF being the original established resolution reference. The original CIF is also known as Full CIF

(FCIF). The bit rates in the chart at right are for uncompressed color frames.

Higher Bit Rates Need More Space

Bit rate is defined as how much physical space an image occupies in 1 second on a network. The higher the bit rate, the more space it requires.

While often referred to as "speed," bit rate does not measure distance/time but quantity/time, and thus should be distinguished from the "propagation speed" (which depends on the transmission medium and has the usual physical meaning).

And as we all are aware of, adding more cameras, increased movement in the video scenes and more remote view locations mean the bit rate plays a very important role when dealing with networks that can have a limited amount of space available for the transmission of video. This bit rate number is also governed by the compression method incorporated by the system.

IP cameras, through their software program, allow the operator to control the bit rate of the camera. This feature is listed under the quality selection section of the setup menus. The result is simple: low bit rate equals poor image quality; higher bit rate equals better image quality.

Armed with this information, let us now investigate some of the features injected into camera design by manufacturers to either help or hinder the overall image file sizes generated by IP video systems.

There Are Pros and Cons to AGC

The first feature open for discussion is automatic gain control (AGC). Many people are already familiar with this feature. However, what does it have in common with IP camera systems? First, for those who are unfamiliar with the function of AGC, a quick update is in order.

The purpose of AGC is to increase the sensitivity of the camera during low-light level applications. Remember, IP cameras are not just for indoor or high light applications. This feature is a compromise because it will amplify the video signal to improve image signal strength at low light levels, but at the same time it also amplifies the noise generated within the camera.

This amplification of noise causes a grainy image that randomly moves about the scene. This random activity throughout the video image is mistaken by most IP compression circuitries as movement and will cause an increase in file size and transmission of bit rates within the networking section of the camera.

This AGC action will definably affect one of the most common features associated with IP video cameras — motion, or activity, detection. This feature is incorporated within the camera to help reduce storage and transmission rates by restricting the camera to either store or transmit images of video when motion or any activity within the scene occurs.

Motion Triggers Camera Recording

This feature has been in place for many years, but has taken on a new role with the introduction of IP and networked cameras. With this feature, the compression process, storage and video transmission is activated only when motion occurs in a fixed or stationary scene. Many digital surveillance cameras now have menus that allow an operator to set areas for motion. This detection is based on changes in video pixel signal strength levels as well as the number of pixels selected in the setup menus of selected cameras.

This form of activity detection is most useful for indoor application where the light levels are sufficient to provide high quality images and have a controlled environment, one that is free from external influences such as cloud cover, movement of trees, reflective light sources, etc. The use of this function in most outdoor applications may result in many false alarms, which causes excessive video file sizes and increases bandwidth issues for a video IP network.

This topic was discussed in Part 1 of this series, however, it is worth repeating especially when motion or activity detection is a consideration in your system configuration.

Activity detection is a method by which the system is only activated when the equipment detects any video signal changes. Under low light level conditions, AGC is usually activated. To digital equipment, however, the AGC noise generated appears to be motion, causing the camera to either start saving video images or transmit these images. The result is large qualities of wasted storage or transmitted media.

Some technicians, when confronted with this situation, usually turn the AGC switch to the off position. This solution may reduce the noise but the video images usually become unusable as well.

This now brings us to the second area of camera specifications: the signal-to-noise ratio (SNR).

50dB Minimum SNR Recommended

By definition, SNR is a ratio of video signal strength vs. the noise signal strength. All circuitry generates internal

Bit Rates at 30 fps

CIF Format	Resolution	Mbps
4CIF (4 X CIF)	704 X 576	146
FCIF (FCIF)	352 X 288	36.5
QCIF (quarter CIF)	176 X 144	9.1
SQCIF (sub-quarter CIF)	128 X 96	4.4

A new image rate has been added to incorporate the introduction of high definition (HD) image production. The new resolution is now defined as:

16CIF (16 X CIF)	1,408 X 1,152	583.9

Automatic Gain Control (AGC) Vs. Bit Rates

Fixed scene

Light - 40 Lux

No AGC

Color

Fixed scene

Light - 10 Lux

Low AGC

Color

Automatic gain control (AGC) is a compromise because it will amplify the video signal to improve image signal strength at low light levels, but at the same time it also amplifies the noise generated within the camera.

noise; this noise becomes a major factor in low light conditions due to the activation of AGC. In short, the poorer the noise ratio the greater the noise generation. Since SNR is measured in decibels (dBs), the lower the number the poorer the noise generation.

It is highly suggested when incorporating cameras and DVRs in the same system, the SNR should be at least 50dB or greater to ensure optimum system performance. This again can cause false activation of motion detection systems used in today's digital recording systems, as well as motion detection in standalone digital multiplexers. This effect on activity or motion detection only occurs if the feature is enabled.

No Flicker Means Smaller Files

Flickerless mode is a feature that can improve the compression of useless video information.

Most compression methods incorporate the removal of nonessential, irrelevant or redundant information, thus storing only the important video information. One of the ways redundancy and irrelevant reduction is accomplished is by removing duplication from the signal source. One of those areas is known as temporal or the correlation between adjacent frames in a sequence of video images.

So how does flickerless mode affect compression and bit rates? Depending on the type of IP cameras or the configuration of the IP network, this feature may or may not improve the performance of a system. First, without getting too technical, we must understand what "flicker" means and what causes it to occur in a video system.

Anyone who has used his or her camcorder in an indoor situation with fluorescent lighting may have already experienced this problem. Flicker is a result of the differences between the frequencies (60Hz) of the ionization of the gas in a fluorescent light fixture with that of the vertical frequency (59.94Hz) in a color camera.

The difference is very small, but the result is a slight flicker at the top of the monitor scene, or to a digital circuit it would appear as movement. This movement will increase bit rates/bandwidth on a network as well raise required storage space on a networked recording device.

So the flickerless mode of operation of a camera eliminates this flicker. The result is reduced file sizes, transfer bit rates of the compressed video image and improved color quality.

Dynamic Range Mimics Human Eye

Many new IP cameras have added wide dynamic range (WDR) to their feature lists. Not only does WDR improve the performance of video image quality, it also helps with the overall image file size as well as the bandwidth requirements when used in a network application. How can this reduction be accomplished? Very simply, once one understands the principles behind WDR parameters.

Dynamic range is an important indicator of the quality of a system intended either to record or to reproduce

How Wide Dynamic Range Affects Images

Wide dynamic range OFF — Wide dynamic range ON

Cameras with super or wide dynamic characteristics are able to show both shadowy nighttime scenes and bright, outdoor sunlit scenes.

information for human perception. Humans' sense of sight has a very high dynamic range. In practice, it is difficult to achieve the full dynamic range seen by human beings using electronic equipment, since most electronic reproduction equipment is essentially linear rather than logarithmic like human perception.

Electronically reproduced video often uses some trickery to fit original material with a wide or super dynamic range into a narrower recorded dynamic range that can more easily be reproduced: this is dynamic compression (commercially the dynamic range is often called the "contrast ratio"). Cameras with super or wide dynamic characteristics are able to show both shadowy nighttime scenes and bright outdoor sunlit scenes.

How does movement affect image file sizes and system bandwidths?

As more and more IP video systems are being deployed for outdoor applications incorporating pan and tilt controls, many new camera features are appearing in order to improve image file sizes as well as transmitted bit rates. Blanking is one of the new features now appearing in IP cameras to help overcome some of the problems associated with movement.

Preset Blanking Eases Transitions

This first feature is known as preset blanking. For those who have not heard or understand the function of presets, a simple explanation is in order. Many pan, tilt and zoom (p/t/z) camera assemblies have a feature in which an operator can place into memory individual p/t/z locations. So instead of having to manually adjust the camera to a desired position, the operator can have the camera and lens automatically go to that location by either a single control or by an alarm event.

This preset function is very helpful during remote alarm conditions or as a preprogrammed sequence of events. However, during the transition from one preset location to another, a great deal of unimportant video information is being digitized, compressed, transmitted and/or stored. This will result in excessive image file sizes or increased bit rates as well as larger storage space.

To eliminate this problem, many manufacturers will now store the last preset into memory and display it on the monitor screen until the next preset has been obtained, blanking out the unusable video information. This procedure helps reduce the overall image file sizes, thus saving both storage space and system bandwidth.

Zone or Area Blanking — Almost the same as preset blanking except for one condition: Zone blanking will blank out an entire area or zone (which is set by a system operator) to eliminate any unnecessary video information from being processed. This blanking area is usually defined as that not being required for video surveillance and, therefore, can be set to improve video traffic over a network.

Let Application Dictate IPS Rate

The last area of IP camera features is selecting the image rate. This selection will help reduce the overall bandwidth requirement in any IP camera system by determining the number of images required to produce a functional system.

In the analog world of cameras, the camera supplied all 30 frames or 60 fields of information at all times. The video IP encoders or DVRs would then

Blanking Increases Video Efficiency

Presets with blanking

Presets without blanking

During the transition from one preset location to another, a lot of unimportant video information is digitized, compressed, transmitted and/or stored. This results in excessive file sizes and storage space. Blanking can help eliminate this problem.

control, via menus, the number of images that would be available for the system. In IP cameras, the number of processed images per second (ips) is a function of the compression system of the IP camera. The number of processed video images is usually controlled by software within the camera itself.

What are suggested ips settings? This setting is usually based on the application of the system. Many locations require a minimum of 15 ips in order to provide proper surveillance. Some surveillance applications can survive on a reduced number of processed images. In some cases, the image rate can be as low as 1-5 ips. The result, however, will be jerkiness of any moving objects. On the upside, however, the storage and bandwidth requirements are greatly reduced.

Another added feature in newer IP cameras is bandwidth restriction, or what some call "throttle back." This feature restricts the amount of information that can be entered into the network by the camera. This feature is a compromise because by limiting the information supplied by the camera, you can limit the quality of the video by restricting the number of processed images, the file size (low or high) and the file format (xCIF). All of these restrictions will compromise overall video quality.

Next Edition to Cover Compression

A word of advice: There are many avenues used to impress and confuse people, so please make sure you ask the right questions and demand answers you can understand. Too many applications are being confused.

Part 3 in this series, scheduled for the August issue, will discuss the different compression methods incorporated into today's IP cameras. ■

Robert (Bob) Wimmer is president of Video Security Consultants and has more than 35 years of experience in CCTV. His consulting firm is noted for technical training, system design, technical support and overall system troubleshooting.