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IR for IP-Based Surveillance Systems

How Effective Night-time Imaging Can Help Prevent System Crashes

... by Peter Beare, Managing Director, European Operations, Extreme CCTV

While IP cameras today are providing important benefits to end-users of security, almost all of them suffer a critical drawback every night: darkness.

FACT: IP cameras suffer in darkness.
If there is no light, there can be no picture. This principle applies to both analog and IP-based CCTV systems. Except in IP systems, lighting becomes more important because systems suffer greater declines in performance. In an analog system, a poor night-time image is a poor night-time image. In an IP system, a poor night-time image is both a poor night-time image and a catalyst for system crashes.

FACT: Signal noise increases bit rate.
Poor night-time performance results in signal noise, the enemy of compression. Poor compression produces high bit rates. For example, a properly functioning IP camera may require as little 10kbps when lighting is good. When darkness falls, the bit rate may rise to 100kbps - a 10x increase - resulting in decreased performance and potential system crashes.

FACT: Night-time performance determines the overall performance of the system.
Any system is only as good as its weakest link. In IP-networked systems, poor night-time images hinder the entire system's performance and can cause system crashes.

IR for IP: Active-Infrared a Necessity for Critical IP Applications with Low-Light

Whether analog or IP, virtually all CCTV cameras produce useable surveillance images under daytime conditions. However, since today's security systems require 24/7 performance, night-time performance determines overall system effectiveness.

As light goes down, the demand for bandwidth may go up exponentially. How so? IP-based CCTV systems can be thought of in five general parts:

1. Video imaging
2. Video encoding and compression
3. Video transmission
4. Video storage
5. Video analytics

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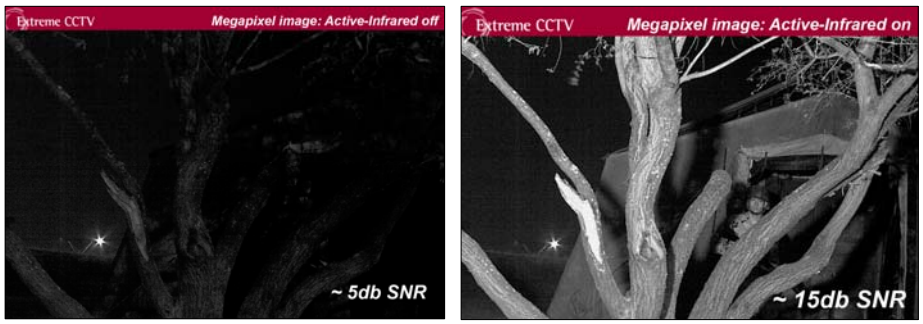
Video imaging can be thought of as the “front end” of the system. Accordingly, if video imaging fails, the other parts of the system simply encode, transmit and store that failure. Ultimately, real-time video analytics, a growing expectation in the IP world, has no useful data to analyze.

To understand the appetite of darkness for bandwidth, consider AGC (automatic gain control), a camera technique that increases signal strength under low light conditions. AGC works by amplifying the image, which increases both video signal and noise. The lower the ambient lighting level, the more AGC amplifies the video signal and the more noise appears in the image.

During daytime, compression algorithms function well and bit rates are acceptable. As the scene gets darker, AGC works harder, creating more noise. Eventually, the night-time image is obscured by snow and graininess. Under these conditions, bit rates become unacceptable and can approach ten times the daytime bit rate, even for non-moving images.



Two pictures of the same dark scene, one without infrared (at left) and one with infrared (at right).

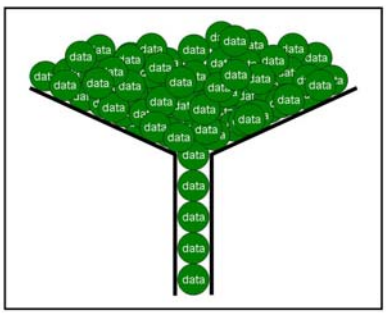
The image with infrared is evenly illuminated and yields a 15db SNR. The image without infrared yields only a 5db SNR and presents much less information, but has a file size that causes an exponentially higher bit rate.

To understand this rise in bit rate, it is necessary to have a basic understanding of compression algorithms. The basic principle of compression is to eliminate useless information to conserve file size. Compression requires a compromise between image quality and file size. Higher compression ratios deliver smaller file sizes but lower quality images. Lower compression ratios produce higher quality images but larger file sizes.

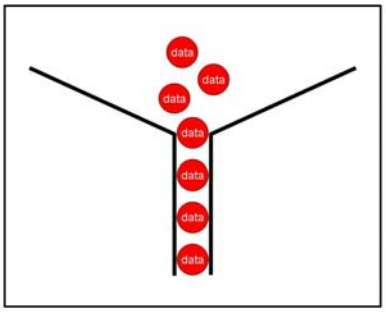
Today’s popular compression engines typically incorporate JPEG, MPEG or M-JPEG, each known as lossy compression algorithms. They use one of two reduction principles:

- Irrelevancy reduction, which removes parts of the video signal not noticeable by the human eye, such as subtle color changes
- Redundancy reduction, which removes duplicated information either from the same frame or between frames, such as large uniform areas of color

Therefore, noise caused by AGC interferes with compression algorithms used in today’s IP cameras. Specifically, compression algorithms falsely interpret the snow and graininess of AGC-enhanced images as useful information that cannot be reduced by either irrelevancy or redundancy. Consequently, night-time images are less efficiently compressed, resulting in large file sizes that convey less useful information.



Above: Bitrate without infrared illumination. A representation of a bottlenecked network caused by data overload associated with high bit rates (~1000kbps).



Above: Bitrate using infrared illumination. A representation of a stable network with acceptable bit rates (~500kbps).

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The direct relationship between night-time performance, compression and bit rates is clear:

Poor night-time imaging performance	Good night-time imaging performance
↓	↓
Poor compression	Good compression
↓	↓
High bit rates	Low bit rates
↓	↓
Poor system performance	Good system performance

It seems that the quickest fix would be to disable AGC. However, doing so would result in very poor - if not useless - night-time images. Clearly, night-time performance of a surveillance system is essential to effective security.

The best solution to ensure effective night-time performance of IP-based systems is to apply infrared illumination to a scene. Providing the IP camera with the right amount of infrared illumination ensures that night-time images are high signal, low noise. Under these conditions, AGC becomes unnecessary and compression functions work well. Bit rates are acceptable and do not cause bandwidth issues or system instability.

Poor night-time imaging performance		Good night-time imaging performance
↓		↓
Poor compression	Black Diamond™ Even Illumination Infrared by Extreme CCTV →	Good compression
↓		↓
High bit rates		Low bit rates
↓		↓
Poor system performance		Good system performance

Left: Two photos of the same dark scene. The photo on the left is 25% larger at 255KB. The photo on the right, although smaller in file size at 202KB, presents infinitely more information.

Large file sizes do not necessarily translate to more information. In digital CCTV pictures, the high-noise video of dark scenes is best avoided with even illumination in bright light or infrared light.

Poor night-time imaging performance

→ Low SN ratio, noisy image
→ Poor compression
→ High bit rates
→ Poor system performance

Good night-time imaging performance

→ High SN ratio, clear image
→ Good compression
→ Low bit rates
→ Good system performance

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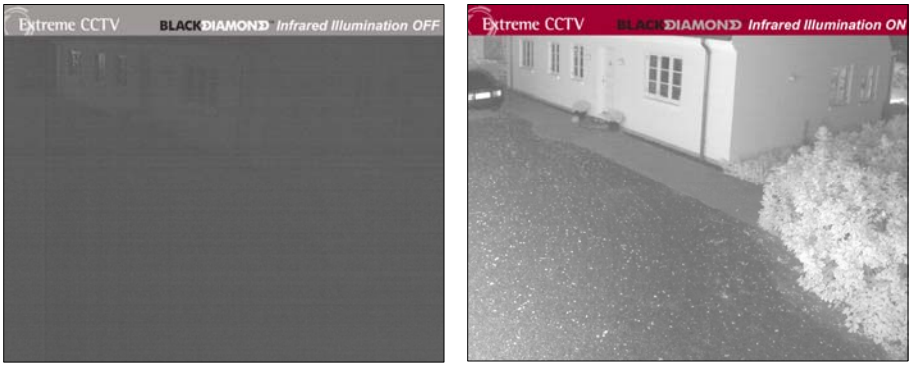
Extreme CCTV provides a solution for high bit rates with Black Diamond™ (patent pending) infrared illumination, which projects light horizontally and evenly in rectangular beam shapes as wide as 135° and ensures Even Illumination from the front to the back of the scene. This High Fidelity™ illumination produces the high quality images that IP systems and megapixel cameras need to function optimally.

Black Diamond™ technology is incorporated into select Extreme products including the EX85 Megapixel-IP Infrared Imager™ and the UFLED Intelligent-IR™ Illuminator.

The EX85 I^3 Megapixel-IP Infrared Imager™combines megapixel sensors, Black Diamond™ technology and IP Infrared Imaging (I^3) to overcome the bit rate problems of poor night-time performance.

Above: Conventional infrared illumination yields a washed out image (above left) with a high-noise darkness around a bright center. Video analytic software requires high-definition, evenly illuminated scenes such as that shown (above right) through an Extreme CCTV EX85 with Black Diamond™ technology.

The UFLED Intelligent-IR™ Illuminator, shown here with a dual-lens megapixel camera, incorporates Black Diamond™ and Constant Light™ technology to deliver high performance infrared illumination.



Above: Two megapixel views of the same scene. Image at left is plunged in darkness and shows no useable information. Scene at right utilizes the UFLED Intelligent-IR™ to produce the High-Fidelity™ lighting that megapixel cameras need to deliver outstanding images.

All of the foregoing discussion on advanced technology equipment with video analytics, megapixel sensors and Black Diamond™ infrared leads back to a basic and conclusive fact: Video surveillance in analog or IP requires adequate illumination. Reliable surveillance is based on clear images, 24/7. Achieving great 24/7 imaging requires good night vision. Effective night vision requires high performance infrared illumination.

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