

The Benefits and Pitfalls of using Megapixel IP CCTV.

White Paper by Nick Hewitson November 2005.

Introduction

The market for video over IP in the security arena has been slow to take off in the UK. Many CCTV professionals have felt that the quality of the data has been significantly worse than the pre existing Analogue systems.

Originally, CCTV video over IP was promoted on a cost saving basis in that the video data could be transmitted over the customers existing IT network infrastructure and thereby significantly reduce the cost of cabling.

At the same time the designers of IP cameras looked to see what the market was currently using. They focussed on the fact that analogue cameras output 25 frames per second and this data rate is thought by the CCTV market to be “real time” video. This was despite the fact that most video tape recorders were multiplexing the camera inputs so each camera was only recorded at a very few frames per second.

This basic misconception as to what the market really needed has led to a number of unfortunate trade offs.

Spatial Resolution

In order to keep the data bandwidth requirements low enough many video over IP cameras have been designed with CIF (320 pixels x 240 pixels) resolution. A PAL analogue camera has almost 480,000 pixels per frame while a CIF image consists of only 76800 pixels. It is immediately clear that the resolution of a CIF image is only 16% of that of the previous generation analogue systems, consequently with much worse quality.

Image Compression

Even with the data reduction created by reducing the spatial resolution the data bandwidth is still usually too high to implement a complete CCTV system using pre-existing IT infrastructure. To reduce the bandwidth requirement further the IP camera manufactures implemented video compression within the camera. Again many of them made an unfortunate decision and decided to use MPEG-4 as their compression method.

At first MPEG-4 looks to be a sensible choice. It is used in huge quantities to encode and decode DVDs and therefore the semiconductor technology was available and cheap. However MPEG-4 was designed to maximise the compression while offering a good image stream to the person watching the DVD. It does this by transmitting a full frame known as the I frame and then a series of partial images whose data is only what has changed since the last I frame. This series of changes might be up to 100 frames before the next I frame update.

The major problems with MPEG-4 are that you can only do check sums on the I frames to prove that no tampering has happened and that it is virtually impossible to do any video content analysis on an MPEG-4 stream because you need the whole of each frame to be able, for example, to track people successfully.

The Benefits of Megapixel cameras

The term Megapixel applies to cameras with a minimum of 1 million pixels although most Megapixel manufacturers start their ranges at 1280 x 1024 or 1.3 million pixels, which is almost three times the resolution of a PAL camera and seventeen times that of a CIF camera. This immediately gives a much better quality image for both forensic and legal purposes. There is little advantage of capturing the perpetrator of a crime at so poor a resolution that you are unable to identify him or her.

The Megapixel camera manufacturers also realised they would have bandwidth problems and have solved it by moving away from the requirement to provide 25 frames per second video. On the basis that time lapse video of 2 to 5 frames a second was good enough when tape recorders were the only method of recording; then higher resolution video at the same frame rate will improve the system not degrade it.

In addition many of them have implemented MJPEG as the compression algorithm, this transmits all of the compressed data every frame and therefore makes the camera much more compatible with future developments of behavioural recognition software.

The Pitfalls of Megapixel cameras

It is a truism of all computing, garbage in = garbage out. The resolution of any electro-optical system is made up of all of the components and is called the Modulation Transfer Frequency, normally referred to as the MTF. The MTF is specified as a number of line pairs per millimetre and if you remember the test card on your television it is a similar grid where you measure the ability to resolve black and white lines that get closer and closer together. The more line pairs the better the resolution.

Historically analogue CCTV cameras have worked with C or CS mount lenses. The MTF of these low quality glass lenses is usually slightly better than the MTF of a PAL resolution camera. Therefore, the camera limits the total MTF. With a CIF resolution camera it is possible to use an even cheaper plastic lens and still have the camera as the MTF limiting factor. However as soon as you increase the camera resolution to Megapixel quality, the MTF of a standard glass C / CS mount lens (let alone a plastic lens) becomes the limiting factor. You have to purchase high quality Megapixel lenses to work with Megapixel cameras to gain the benefit. Unfortunately these are more expensive due to smaller manufacturing batches at higher quality. It is however a waste of money to specify high-resolution cameras without specifying high-resolution optics.

Another lens problem is due to the fact that often Megapixel sensors are of 1 inch (or even more) format. Using a lens designed to work with a 2/3 inch or less sensor will clip the image resolution and often lead to a darkening towards the edges of the image.

We have seen implementations of Megapixel cameras where a highly inappropriate lens has been sold with the camera leading to the customer believing that the Megapixel camera gave no resolution benefit over his old PAL camera when a simple lens change gave him a much improved image.

Unless only a very few Megapixel cameras are going to be deployed the output data rate is sufficiently high that dedicated network infrastructure will be required and potentially more hard disk space will be required in order to store 31 days of video. However the cost of hard disk storage continues to fall so this is becoming less of a problem.

Conclusion

Megapixel cameras are not the solution to every problem. A door entry system monitored by a guard will be much more cost effective using a CIF and MPEG-4 camera. However where image quality is key to the operational requirements of the CCTV installation, the additional marginal cost in implementing Megapixel cameras in those locations which require them is small compared with the total cost of ownership of the CCTV system over its expected life.

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