4k and beyond!

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The electronics industry is one of the most efficient and productive technologies of modern times.

In the late 1940's and after the invention of transistors following WWII, the electronics industry has continued to evolve and develop, from the humble transistor to the latest super microprocessors.
The electronics industry has also helped convert cameras from the old film type, through tube pick-up devices to the modern electronic counterparts with CCD technology, and now CMOS. We have already witnessed a major change from the old Standard Definition analogue electronic cameras, with 576 active television lines created in the 1960's, to the modern High Definition (HD) digital cameras with 1080 lines created in only a few years ago.

High Definition is a digital video format used from its source, rather than being converted from analogue into digital: as was the case with DVD media. The HD television format is the current television standard and it is also known as 1080HD, with 1920 horizontal by 1080 vertical pixels.
Essentially, HD offers 5 times the pixel count of D1 resolution.

When an HD signal is produced by a camera, it appears as a 1.5 Gb/s or 3 Gb/s stream, depending on whether it is 1080i (interlaced) or 1080p (progressive). This is huge data traffic coming out of a digital camera, impossible to imagine twenty years ago. In order to be able to transmit and store such a huge amount of video data, a new video compression was needed. This was done with the now common standard H.264 compression, introduced about twelve years ago. The H.264 is also known as AVC (Advanced Video Coding).

The latest camera sensor technologies are now offering even larger video formats than HD, the so called 4k video, with quadrupled pixel count compared to HD, i.e. 3840x2160 pixels. Using the current terminology for HD, which we refer to as 1080 HD, the 4k could also be referred to as 2160 HD, but it is also known as Ultra-HD-1 resolution.
Many broadcast studios, and many production houses, are already using 4k on their movie sets.
The CCTV industry has started to embrace 4k technology already. There are a number of manufacturers that have at least one 4k type camera in their range.

The 4k is basically equal to a live streaming of 8 mega pixel video, of which an uncompressed stream occupies around 12 Gb/s. So, without any doubt, in CCTV we have no choice but to compress the 4k stream. The H.264 compression can be applied to 4k video too, but more efficient video compression was needed. So, only two years ago, a new video compression, the H.265, also called High Efficiency Video Codec (HEVC), was introduced.

An even more impressive format called 8k is currently being developed and tested, offering another quadruple resolution to the 4k, with 7680x4320 pixels, which is almost 32 mega pixels of live streaming video. This is known as Ultra-HD-2.

When viewing 4k, and 8k video, a viewer sits closer to the display relative to the viewable details and this immerses the visual sensors completely. It is said that the viewing experience is almost three dimensional without having the 3D goggles. This was reported by many viewers watching the London Olympics in 2012 with an experimental 8k video.

The CCTV industry, unlike the broadcast industry, always tries to minimise its cost of the equipment, while still maximising recorded pixels and extending storage time.This is not easily done, but the trends are certainly going in that direction. One way to reduce the cost of high resolution cameras is to make the sensors smaller, despite increasing the number of pixels. Making smaller sensors means lenses with smaller projection circles, which means smaller lenses. Ultimately smaller lenses means less glass and lower cost.

Unfortunately, the miniaturisation of sensors means smaller pixels, and this in turn means more noise and lesser dynamic range. When the imaging sensors are getting smaller, and at the same time the number of pixels are increased, (for example, when going from HD to 4k), then the result is even smaller pixels and even more noise. Smaller and more dense pixels require even better optics, better than what we have been used to from the analogue days. To top it off, more pixels means streaming more data, which requires better network and more storage requirements.

At first glance, the above barriers to advancement make the new 4k (and certainly the upcoming 8k) almost impossible to implement, expensive and unattractive, to say the least. Yet, the modern demand for more pixels, sharper details and larger storage is insatiable. This demand ultimately drives technology toward new solutions, better sensors, more storage, better lenses, and paradoxically, lower prices. This is important for us in CCTV!

To illustrate, people with longer experience in the CCTV industry will remember that some of the first analogue CCD cameras, back in the early 1990's, were over $1200 — and that was excluding the lens. Today, an HD or mega-pixel camera, with lens — even with built-in zoom lens — with *smart* electronics, would cost no more than half the amount that we paid two decades ago. Even the 4k models now appearing on the market are not much more expensive.

Similarly, the first large LCD television sets from ten years ago, were close to $10,000. Only a few years later, their prices plummeted to only a couple of thousand dollars. It is evident that 4k has arrived in consumer electronics as well, with 4k television sets costing nearly the same amount.

It is unnecessary to forewarn future users of 4k CCTV cameras that it is pointless buying such cameras without having 4k monitors. You can certainly display 4k cameras on an HD monitor, as they have the same aspect ratio of 16:9, but don't forget that the standard HDMI cable will also need updating. The cables designed for 4k resolution are called Display Port cables, however the latest HDMI v.1.4 will support 4k as well.

In most CCTV applications, using 4k cameras will be by way of using some version of Windows OS, a super fast processor and super powerful graphics card. Certainly you would need a 4k capable computer display and there are not many out there. Most users would opt for a 4k TV display, which physically is much larger than a conventional computer monitor. You will need quite a lot of processing power to decode one or more 4k video streams. Only the latest versions of Windows, with a special graphics card, may support 4k resolution.

Definitely 4k is here, yet people deciding on 4k today should take into account the above mentioned "side effects": smaller pixels, low light performance, the optics required, increased network bandwidth, storage load and demands on computer decoding power. You may have to check all this before deciding whether 4k is for you with the current computer hardware and software you own. If all of the above boxes are ticked, then go for it!

Broadcast people are already using 4k for their daily production. One such Australian company BlackMagic Design, is making very affordable yet excellent quality 4k cameras for video production. Yet the broadcast industry makes good money through their productions and they don't shy away from spending good money for good results. In comparison, the CCTV industry is one of the most penny-pinching industries. It is not easy to be innovative in technology without prior training, learning and without spending money, even when all the boxes are ticked.

The 4k will certainly not be the concluding component in our technology, it is a part of the electronics industry's advancement. I'm always inspired and encouraged within 'my' industry when 'new kids on the block', such as the 4k, come along.