Keys to Delivering on the Promise of 4K Video

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Alignment in purpose of selection of systems – both hardware and software – for key applications can make the difference in justifying the implementation 4k video systems today.

In the business world, video surveillance has often been considered a necessary cost of doing business. Initial investment in any new system comes out of a company's capital expenditure and 'returns' can be difficult to calculate mainly if it simply works to deter crime, or cost avoidance. Managers have had the difficult challenge of justifying an investment without having a hard target for Return On a new system's Investment (ROI).

But increased quality and resolution of these systems increases the value of that investment and the potential return it can provide. With the advent of 4K, offering four times higher the resolution and pixels on target than HD, you can expect to increase the value of your system's investment more easily. More pixels on target, combined with content analytics, offers the potential for genuine calculation of ROI.

Traditional loss prevention applications such as Point Of Sale and cash till monitoring, remain strong applications for high resolution systems such as 4k, with camera count reduction being an obvious win in terms of cost of acquisition and system maintenance. In one major UK retailer, clever deployment of high resolution cameras, video management software and analytics nearly halved its shrinkage from 0.81% to just 0.44% within the first two years – which translated into hundreds of thousands of pounds of savings. In so doing, the number of employees caught in the act increased five-fold.

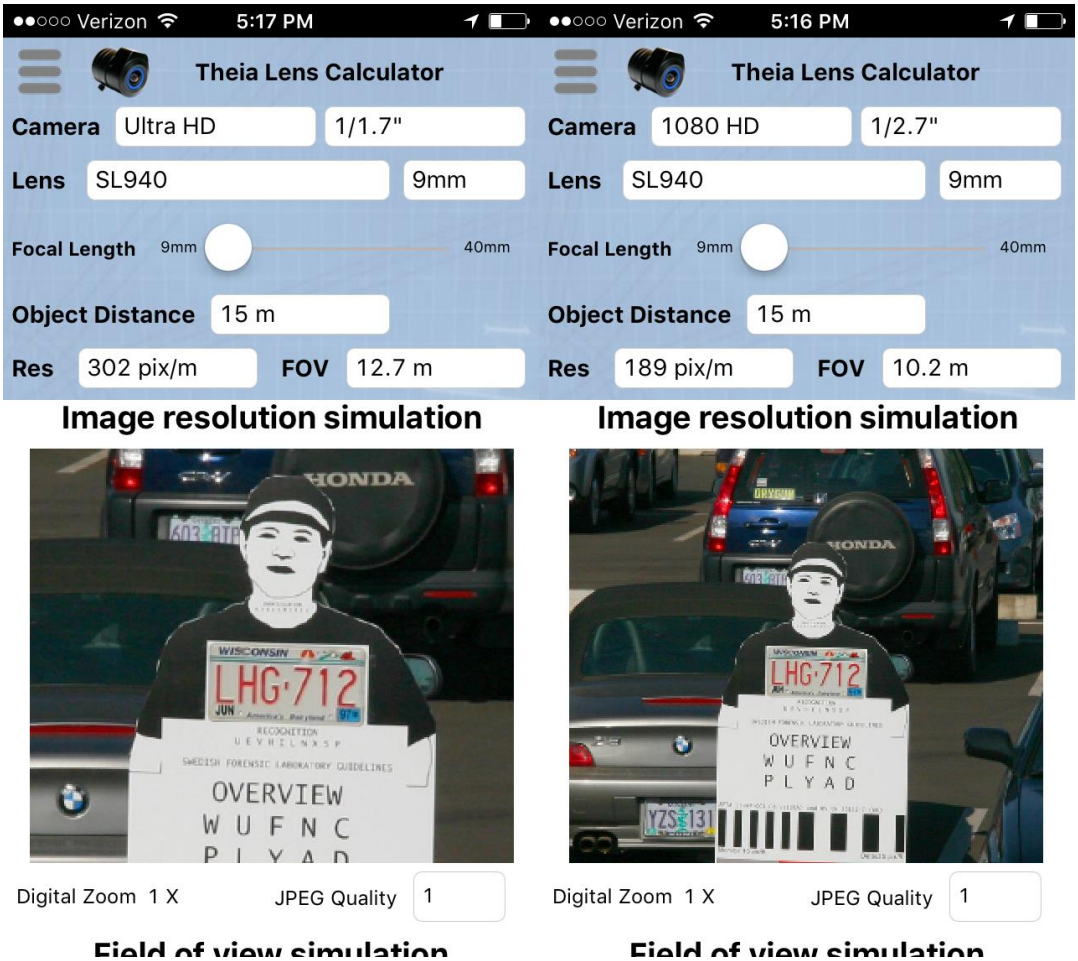
Beyond traditional loss prevention efforts, 4K resolution-based installations can unlock cost reductions in direct security operations, supporting ROI. For example, one US Fortune 500 company was able to deliver a 33% reduction in its video systems' running costs. They calculated cost of use in terms of man-hours required to retrieve and review event footage. With a higher resolution video system, not only were they able to reduce the man-hours required for this activity, but also cut the cost per hour of running the system.

The reduction in man-hours was achieved because the higher resolution system enabled the use of more video content analytics software to automate the review of the system footage. Put simply, analytics algorithms find higher quality images easier to process. They become more accurate and reliable in spotting anomalies as a result. The cost per hour reduction was achieved by reducing guard headcount since, as routine monitoring tasks were being automated, fewer staff were needed to follow up on only pre-qualified abnormal behaviours and events.

Just as 250 pixels per metre is becoming the standard for facial recognition in the UK and the rest of EMEA, in the United States the Security Industry Association recommends 80 pixels per foot for a host of

video systems tasks. Automatic Number Plate Recognition (ANPR) and facial recognition have long been associated with higher image resolution requirements. However, a number of other video content analytics-based applications demand higher specification systems to deliver to their full potential.

One way to look at it is shown in the images below. With an Ultra HD 4k camera it's easier to get the required 250 pixels per metre than with an HD camera. In this case with a 9mm lens on an HD camera positioned 15 metres away, you can only get 189 pixels per metre (see image on the right); while with an Ultra HD 4k camera together with the same lens from the same 15m distance you can get nearly twice as much detail - 302 pixels/metre (see image on the left).



In manufacturing operations, high resolution video surveillance systems are being deployed to serve multiple department heads responsible for areas as diverse as security, health and safety monitoring, quality control and operations. Such systems can be used to provide video evidence to resolve conflicts in a worker's compensation claim; monitor staff behaviour to a level where managers can intervene early enough to prevent accidents and manufacturing errors; as well as verifying workers' hours – most of which require (or would be greatly facilitated by) higher resolution 80 pixels per foot systems. In one

US manufacturing plant, supervisors documented a 20% increase in productivity from better supervisory monitoring of the shop floor, warehouse and delivery areas, using a new high resolution video system.

Finally, by bringing together 4k, analytics, cloud storage and 'big data', it becomes possible to deliver concrete and accelerated ROI in a more consistent manner. 4K video data, combined with these technologies will enable data from various sources to form a powerful source of business intelligence.

A 4k video system can be used to monitor a shop's aisles for loss prevention and the same video data can mined to help understand consumer behaviour via 'heat mapping' analysis of traffic patterns, people counting, etc. The resulting intelligence can be used to develop tools to increase sales such as targeted sales promotions, queue management, improved store layouts, etc.

Justifying an investment in 4k video becomes easier when you include traditional loss prevention, operational cost reductions and efficiencies, and potentially now - top-line revenue increases from better merchandising and store management.

So to make a strong business case for 4k systems, managers will still need to funnel investment towards the areas where they see the highest risk of losses. To this end, securing areas where there is significant risk to human life or high value assets are two clear areas where we anticipate early adoption of 4K: power plants, chemical plants, airports, stadiums, casinos and banks for example. In addition, managers across any large organisation can share the system to realise benefits in multiple departments and build an ROI story much quicker as a result.

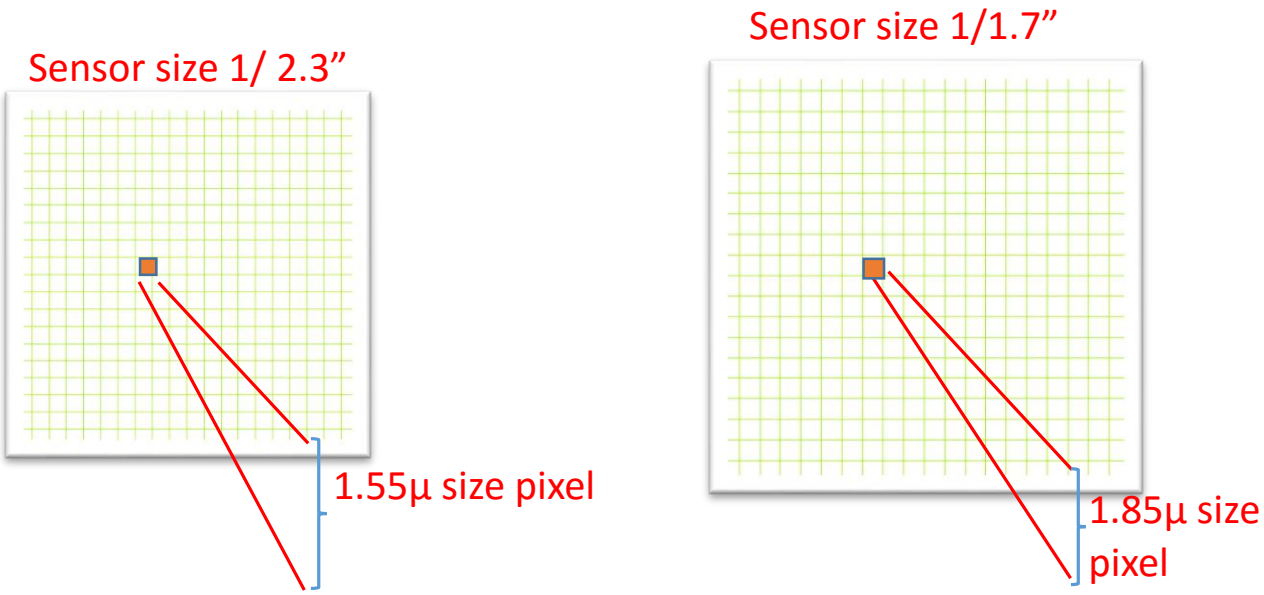
But with all the resolution promises of megapixel cameras, HD is only now reaching critical mass in the security industry. Why should we believe what we are told about 4k? Will we be left with broken systems, faded images, and vanishing ROI?

Much has already been written about the factors affecting the adoption of 4K as a standard in the security industry. These typically include the cost of infrastructure and hardware. However, technological and market advances are addressing these limitations with the introduction of H.265 compression and the rapidly declining price of 4K monitors. With these advances 4K is on course to become the next big video surveillance standard within 2-5 years.

But not much has been written on the importance of finding compatible high performance lenses for use in these emerging 4K systems. Without a compatible lens, the lens will become the limiting factor in the system, throttling the overall image resolution performance, effectively wasting the investment by delivering sub-4K images.

There are only a few commonly used 4K sensors in the security market today. These sensors are not much larger than those used for HD or higher megapixel resolution cameras, but their pixel count is significantly higher and the pixel sizes they generate are necessarily much smaller.

For example, while a typical 5 megapixel sensor is 1/ 2.5” in size with 2.3 micron-sized pixels, the IMX172 4K sensor from Sony is 1/ 2.3” in size, with 1.55 micron-sized pixels – that’s 33% smaller than the pixels of the 5 megapixel sensor. Meanwhile the Sony IMX226 sensor is larger at 1/1.7” in size with 1.85 micron-sized pixels - 19% larger than the pixels of the IMX172 sensor, but still 20% smaller than the typical 5 megapixel sensor pixel size.



The pixel size also dictates the level of contrast in line pairs per millimetre that the lens is required to resolve. For example, the smaller 1.55 micron-sized pixel requires the lens be able to distinguish 300 line pairs per millimetre, while the 1.85 micron-sized pixel requires the lens distinguish 270 lp/mm.

Finding a lens with the power to resolve the smaller size pixels and deliver adequate contrast is a challenge. The focal plane spot size of the lens must be comparable or smaller than the pixel size on the sensor (Figures A and B), otherwise the rays of light trained through the lens will fall off the pixel and the image will be muddy, instead of crisp.

Fig. A 4K lenses focus the light to a small spot

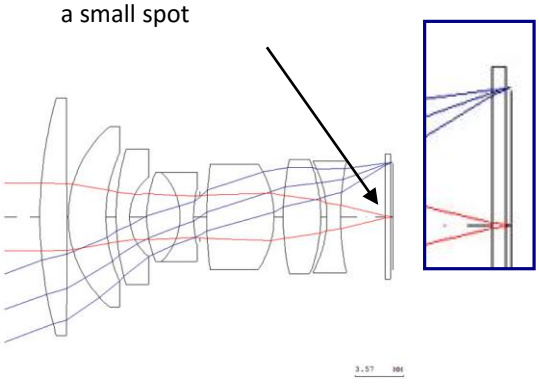
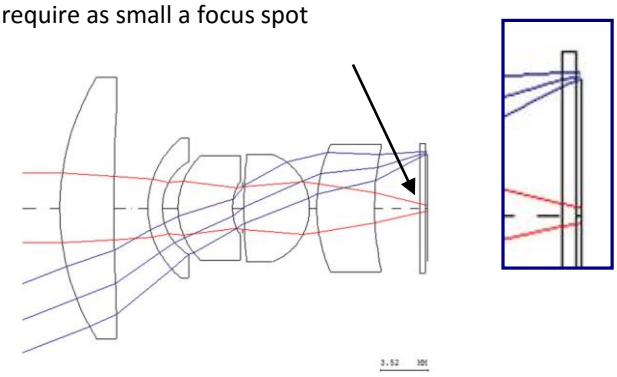


Fig. B Bigger pixels of larger sensors don’t require as small a focus spot



The availability of lenses which can resolve these small 4K pixels is limited right now. They typically require a more complex lens design. The design requires a greater number of more complicated elements such as plastic molded aspheres. They need better glass, plastics, and coating materials. Adding IR correction for Day/Night performance in 4K resolution, presents further design, manufacture and cost challenges to work through.

Camera companies have in some cases paired fixed focal length machine vision lenses with their newly-minted 4K cameras. Varifocal lenses which give the installer more control over fine- tuning field of view and fewer lens types to order are even more difficult to find right now with acceptable 4k performance, especially in sizes compact enough fit in reasonably-sized dome cameras.

As one can imagine, the smaller size 4K pixels cannot physically collect as much light as those of the larger pixel size sensors. This reduces image quality in low light conditions. This would lead one to believe that the industry would be more inclined to adopt the larger, 1/ 1.7" pixel-sized sensor.

However, a larger sensor requires larger lenses, making both sensor and lens more expensive. So from this we can predict that the smaller, 1/2.3" 4K image sensors will be selected for 4K economy-line cameras; while the larger 1/1.7" sensors may be reserved for top-end, 'high performance' 4K cameras. The cameras and lenses are still only made in low volumes, making them more expensive.

These higher performance, higher resolution lenses support smaller pixels. They also increase the complexity and cost of lenses. However, without these new lenses, 4K is in danger of over-promising and under-delivering.

The selection of 4k rated hardware and systems, when used in key applications, can make an easily supported business case.