Telairity Dives Deep Into 4K Technology – Part 7

Clearly, display manufacturers are the group that is most enthusiastic about the new "4K" UHD standard. Given the ability to manufacture a screen with 8 million pixels, each able to display a broader range of "10-bit" HDR[5] colors, the advantage to embracing the new UHD standard for this group is obvious. Just as HD converted a mature, no-growth market for SD screens into a high-growth market for HD screens 10 years ago, now UHD now has the same promise to revitalize an increasingly stagnant market for HD displays.

Of course, the responsibility for the new standard born by display manufacturers ends with providing a UHD-capable screen. Is there any content available able to take advantage of 4X higher resolutions, 2X faster frame rates, and a 1.25X increase in color data? For display makers, at least, content delivery is not a problem—or, at least, not beyond the need to help foster the conviction that UHD content is coming, as necessary to encourage screen sales. The importance of UHD to a display manufacturer is not that UHD, when fully implemented, helps create a more immersive viewing experience. Rather, it is simply that the new standard makes all HD TVs obsolete, hopefully precipitating a new UHD buying cycle.

There is a cautionary lesson here. Once the 2K-to-4K transition is largely over, the incentive for display manufacturers is to begin promoting whatever new standard advancing display technology makes possible. From this viewpoint, the good news is that a new standard is already on the books: the "8K" UHD resolution standard. 8K is a doubling of 4K L X W numbers, to arrays of 7680 x 4320 pixels, or roughly 8K x 4K = 32 million pixels. This quadruples 4K UHD resolution, in exactly the same way 4K quadruples 2K HD resolution.

Of course, the lurking 8K UHD standard does not stop with quadrupling the pixel count of 4K UHD, any more than 4K stopped with quadrupling the pixel count of 2K HD. It also pushes on from 10-bit to 12-bit color channels (36-bit pixels), and allows another doubling of the frame rate, to 120 fps. So the increase over full 4K data rates for full 8K is really another 3-term multiplication problem: 4 x 1.20 x 2 = 9.6X. Piled on top of the 10 increase required by full 4K, full 8K, then, represents an increase of nearly 100 times the data rate of full HD.

But even a 100X increase in current HD data rates is not a problem for display companies, since their business stops with selling the display. Figuring out how to transmit two orders of magnitude more data to new 8K screens is someone else's problem. As long as technology supports the manufacture of still higher resolution displays, and customers looking to buy a new TV set believe a 4K UHD screen is better than a 2K HD screen, and an 8K UHD screen is better than a 4K UHD screen—and can be persuaded to buy the latest resolution standard—there is no reason for display manufacturers to want the drive towards a new, higher resolution standard every decade or so to ever stop. ("16K" anyone?)

So who does care that new resolution standards mean skyrocketing bitrates? We will turn to that question in the next part of this series.

[5]Since we broached the topic of HDR or High Dynamic Range color in the previous part of this series, it is only appropriate to provide a brief explanation of this topic. We have already mentioned one way in which artificial capture technologies may exceed the capabilities of the human eye, namely, in their ability to detect wavelength differences within the visible spectrum too subtle to be noticed by the roughly 6 million color-sensitive cones in our eyes. Thus, while the human eye cannot profitably exceed 8-bit "true color" channels (since its ability to discriminate distinct shades of a color tops out somewhere around 150), our superhumanly sensitive cameras and scanners might need to discriminate considerably more than 256 shades per primary color channel.

However, there is also an important way in which the human eye is generally superior to artificial capture mechanisms. The 120 million or so highly sensitive rods in our eyes, which detect light levels, respond to a much wider range of luminosities than our light-recording mechanisms can capture.

This issue is familiar to anyone who has ever had to select a camera exposure value ("f-stop" and shutter speed combination) for a scene with strong light to dark contrasts. The eye, with its naturally high dynamic range, can make out details at both ends of this light-to-dark spectrum. Relatively speaking, however, our light-recording mechanisms typically have low dynamic ranges.

In practice, this means that, setting a camera at one end of its exposure scale, results in darker parts of the image taking on enough contrast to distinguish features, while lighter parts of the image wash out. Conversely, setting the exposure at the other end of the scale, results in lighter parts taking on enough contrast to make out features, while darker parts black out. Whereas, the compromise of setting the exposure in the middle, results in feature loss in both the darkest and lightest parts of the image.

HDR color solves this problem, in effect, by taking three different exposures of every scene, one optimized for the lighter parts, one optimized for the darker parts, and one optimized for the middle parts. The best parts of each of the three resulting images are then combined into a single image, that more nearly represents the high dynamic range the eye perceives when viewing the scene.

The problem for classic 8-bit "true color" coding is not merely that 8-bit channels are inadequate for capturing HDR images, but high dynamic range images cannot be reproduced on displays using just 24 bits/pixel. The recent (August, 2015) Consumer Electronics Association HDR10 Media Profile standard, for HDR compatible displays, uses 10-bit channels (as the "HDR10" name suggests). Of course, 10-bit channels require displays to process 30 bits of color information for pixels, which is to say, to make use of HDR capabilities, content providers must transmit 30 bits of color information to displays for pixels.