Telairity Deep Dives Into 4K Technology – Part 9

For display manufacturers, UHD is pure opportunity. For forward-thinking video providers, UHD is the next step in the evolution of video technology. The crisis posed by UHD only appears when we turn to the task of actually moving the massively increased amounts of data generated by UHD programs to UHD receivers in real time.

The height and breadth of the roadblock preventing the dawn of the rosy 4K future being promoted today by set manufacturers and content providers can be glimpsed by returning to a figure quoted earlier in this series: Netflix and You Tube together account for over half of all peak Internet traffic today. Replacing even 10% of that traffic with 10X more expansive UHD data would generate *more traffic than the entire Internet handles today*. Leaving no capacity for anyone not on Netflix and You Tube to do anything at all, not to mention no room for the remaining 90% of the Netflix/You Tube audience to move up to UHD.

If that reflection is not sufficiently sobering, consider our one and only historical precedent for a transition from HD to UHD, namely, the transition from SD to HD. Serious research into new HD formats for commercial television started back in the 1960s, with attempts to demonstrate viable HD systems beginning in the 1970s and continuing through the 1980s. The pertinent point for this discussion is that all these efforts, based on established over-air analog technologies, ultimately failed for one and the same reason: there was no practically feasible and generally available way to move four to six times as much data for a new HD format across existing channels.

This 30-year impasse was finally resolved in the 1990s, by the development of new digital technology. Critical for HD is the fact that, among other advantages, digital imaging allows the use of data compression. Of course, data compression did not actually remove the bandwidth bottleneck that had stifled earlier HD initiatives; rather, it choked the data that needed to be transmitted down to a size that would fit through new digital pipes. Indeed, data compression was so successful at reducing bandwidth needs that, during 2005-2010, the FCC actually reassigned bandwidth, formerly allocated to broadcasters, to Sprint/Nextel for cellular use.[7]

The bad news for the HD to UHD transition is that the analog to digital conversion is a one-trick pony. There is no similar technical legerdemain now waiting in the wings to enable an upgrade to UHD. In today's all-digital world, the only relevant difference between HD and UHD is the difference between some bits and an order of magnitude more bits. The optimism that underlies UHD, then, is not a belief in some fundamental technological shift, but rather the conviction that digital technology is highly elastic, able to accommodate rising numbers of bits through many doubling cycles.

Of course, there is a familiar and very practical demonstration of the ability of technology to expand in precisely this way, namely, Moore's Law, which postulates that semiconductor technology can double the number of transistors on a chip every couple of years. Over the

course of the last 57 years, Moore's law has carried chip makers across 33 doubling cycles, from a single transistor in 1959 to over 8 billion transistors today, with no clear end yet in sight.

For digital video, the postulated elasticity of bit transmission must be founded on some combination of the abilities to contract the rising flood of bits, through improved digital compression technology, and to increase digital channel capacity, to accommodate however many bits cannot be eliminated.

But even if technical optimism about improvements to these two digital abilities is well founded, there remain serious practical considerations for broadcasters, many of whom are still in the process of fully upgrading from SD to HD. To what extent will 4K UHD require ripping out all their lately acquired HD infrastructure? Enthusiasm for this prospect, likely low to begin with, is certain to be depressed still further by the reflection that the reward for successfully negotiating the 2K-to-4K transition is probably nothing more than the opportunity to do it all over again, to support a looming 4K-to-8K transition.

In the next part of this series we will look at the contribution better compression technology can make toward stemming the rising tide of UHD bits. That, in turn, will let us estimate the expansion in data rates needed to accommodate widespread UHD programming.

[7]The so-called "2 GHz relocation" of 7 Broadcast Auxiliary Service (BAS) channels. These were 17/18-MHz wide analog channels, located between 1990 and 2110 MHz. This radio frequency band was allocated to broadcasters for internal communication between studios and outside locations (aka "backhaul" channels, to fixed transmitter sites, fixed field cameras, or mobile field reporters). The Sprint/Nextel initiative converted these 7 analog channels to 7 narrower 12-MHz wide digital channels, located in the upper 70% of the old analog band, between 2025.5 and 2109.5 MHz. The excluded frequencies, in the lower 30% of the band between 1990 and 2025, were then reassigned to Sprint/Nextel, to expand its adjacent Personal Communications Service (PCS) band (which ran between 1850-1990 MHz). As incentive for surrendering 30% of their analog BAS bandwidth, Sprint/Nextel bought new digital equipment for all the broadcasters who, to continue using auxiliary services, were forced to convert to the reassigned 12 MHz digital channels.

The power of digital compression can be seen in the fact that the old analog BAS channels, with 17-18 MHz of bandwidth, were unable to accommodate even a single HD channel; while, using advanced MPEG-4 compression (H.264/AVC) over the narrower 12 MHz digital band, broadcasters were easily able to accommodate 2 HD channels at the same time (each at a relatively robust data rate of 6 Mbps). As a consequence, in the 2005-2010 timeframe, pioneering local stations who upgraded their broadcast studios and operation centers to HD, were able to conclude an "all HD" news upgrade, also shifting their field reporting (aka "ENG" for Electronic News Gathering) to the new HD standard, using digital HD cameras, MPEG-4 encoders, and digital transmitters and receivers purchased with Sprint/Nextel money.