Telairity Dives Deep into 4K Technology – Part 10

Clearly the best way to deal with the rising floodtide of bits created by UHD would be to simply eliminate it by improvements in data compression technology. In large part, this *is* the story of the SD to HD transition. The switch from MPEG-2 to the more aggressive set of compression tools in MPEG-4 successfully reduced the flood of additional bits created by HD to something closer to a trickle (where it did not eliminate it entirely).

To take just one data point, with MPEG-2 technology, CableLabs recommended minimum video streaming rates over cable of 3.75 Mbps for SD, but 15 Mbps for HD, i.e. a 400% increase to enable the new resolution standard. Using MPEG-4 technology, however, Netflix now streams full HD at a maximum rate of 5.8 Mbps, a relatively modest increase of just 55% over the 3.75 Mbps rate recommended for MPEG-2 SD. And even that modest increase can be more than halved by dropping to an "HD Lite" format, which Netflix streams at a minimum of just 2.35 Mbps. The bottom line here is simply that the overall impact of the SD to HD transition, in terms of escalating bitrates, was largely if not entirely cancelled by better compression technology.

There is, therefore, historical precedent for thinking that that a similar scenario may play out for the HD to UHD transition. It is worth pausing here to briefly review the history of digital video compression. Although useful digital data compression dates back to 1951[8], the very dawn of the computer era, digital video compression is much newer. The Moving Pictures Expert Group (MPEG) was not formed until 1988, and did not issue its initial MPEG-1 standard (aimed at CIF-format video conferencing) until 1993. MPEG-2, the first standard aimed at broadcast-level video ("full SD" 704 x 480/566 interlaced formats), appeared the following year.

Although MPEG-2 was successfully upgraded to handle new HD resolutions (both 720p and 1080i)—leading to abandonment of a proposed MPEG-3 standard for HD broadcasting—the resulting bitrates for high quality video tended to overwhelm transmission resources. As mentioned above, 15 Mbps was recommended as a minimum for digital cable, while the standard ATSC rate for over-the-air broadcasting, 19.4 Mbps, was set even higher. Lowering these MPEG-2 bitrates by reducing video quality tended to defeat the whole purpose of HD. Which is not to say it was never done, as some cable providers scrambled to provide HD services by streaming MPEG-2 in the 10-14 Mbps range.

The saving grace for HD turned out to be the fact that it was slow to ramp. Although the HD standard itself dates to 1996, with the first HD broadcast occurring in 1998, HDTV penetration of U.S. households did not pass the 10% mark until 2007. This provided time for the MPEG committee to develop a robust set of more aggressive compression tools, organized under a new MPEG-4[9] standard. MPEG-4 is also known by acronym, as AVC (for Advanced Video Coding), as well as by its ITU-T designation, H.264.

As mentioned above, the timely arrival of MPEG-4 compression, with its ability to cut HD data rates back to near-SD levels, prevented HD programming from ever generating a widespread bandwidth bottleneck crisis for transmission of video signals, whether beamed to satellites, sent across cables, streamed on the internet, or broadcast over the air.

Are we now posed to repeat this success one more time? Just as MPEG-4 compression appeared at the beginning of the HD era, so the first version of a new MPEG-5 standard was released in 2013, at the beginning of a new UHD era. Like MPEG-4, MPEG-5 is also known by acronym, as HEVC (for High Efficiency Video Coding), and by its ITU-T designation, H.265. The 10-year intervals between MPEG-2 (1994), MPEG-4 (2003, 2005), and MPEG-5 (2013) seem too precise to be just a coincidence. Presumably, as MPEG-4 arrived just in time to facilitate transition to the new HD resolution standard, so MPEG-5 is arriving just in time to facilitate transition to the new UHD resolution standard.

Sadly, the short answer to the question, whether MPEG-5 can repeat the success of MPEG-4 in stemming the rising floodtide of bits caused by a new resolution standard, is "no". We will look at this short answer in more depth in the next part of this series.

[8]1951 is both the year the first commercial computer, UNIVAC I, was sold to the U.S. Census Bureau, and the year an MIT doctoral student named David Huffman developed the first successful algorithm for generating prefix-free variable length codes (aka "Huffman" codes). The basic idea behind Huffman's variable length coding (VLC)—namely, use the shortest binary codes for the data that appears most frequently—has since been refined, first as CAVLC (Context Adaptive Variable Length Coding), then as CABAC (Context Adaptive Binary Arithmetic Coding), but Huffman's key insight remains at the heart of lossless or "entropy" compression.

[9]Since the MPEG-3 name had been assigned to the aborted attempt to develop a separate standard for HD, the naming of released MPEG standards skips from MPEG-2 to MPEG-4. The MPEG-4 standard was released in 2003, and received a set of major fidelity range extensions (frext) in 2005. These extensions included a new "High" profile that significantly improved compression rates over the original "Main" profile (e.g., by replacing CAVLC with CABAC). Therefore, as HD programming started to spread widely in 2007, High profile was widely adopted by broadcasters as the preferred version of MPEG-4.