Telairity Dives Deep into 4K Technology – Part 13

As mentioned earlier in this series, the upgrade from SD to HD resolutions was made possible by shifting TV broadcasts from analog to digital technology. The original digital standard, ATSC 1.0 (from the Advanced Television Systems Committee), was finalized in 1996, the same year the HD standard itself was approved. For purposes of the present discussion, there are two critical points about ATSC 1.0: an 8-VSB RF modulation scheme, and MPEG-2 data compression.

8-VSB is an 8-level Vestigial SideBand scheme that, given a 6 MHz RF channel, is able to transmit 1 of 8 possible 3-bit digital codes (000 to 111) 10.76 million times a second. A little multiplication (3 x 10.76) shows this generates a raw data rate of about 32 Mbps. However, due to overhead[10], the usable amount of data from this scheme is only about 19.4 Mbps.

The selection of MPEG-2, as the technology for video data compression, is unsurprising, since it was the only MPEG compression standard available for broadcast TV in 1996. Which is to say, every ATSC 1.0 RF tuner produced over the past 20 years, from 1996 to 2016 (now), has included an MPEG-2 decoder.

Using current ATSC 1.0 technology, then, over-air stations are able to broadcast HD programs in MPEG-2 at up to 19.4 Mbps. While this exceeds the minimum 15 Mbps bitrate recommended for MPEG-2 HD by CableLabs, it provides little headroom for any higher resolution standard. In particular, an MPEG-2 4K UHD signal would require something like 75 Mbps (far in excess of even the 32 Mbps raw data rate available).

Clearly, what over-air 4K programming needs is a new version of ATSC technology. Preferably, the new standard will upgrade both of the critical bandwidth features listed above: first, the RF modulation scheme, to maximize the number of bits that can be pumped over a 6 MHz RF channel[11]; and second, the compression standard, to minimize the number of bits that need to be pumped.

The good news is that this new standard, ATSC 3.0[12], is already far along in committee. A final version should be approved sometime in 2017. To be sure, judging by the history of ATSC 1.0—approved in 1996, but not fully implemented until 2011—the prospect of ATSC 3.0 coming to a TV set near you is still some distance off. Setting that issue aside for the moment, however, how much bandwidth improvement does ATSC 3.0 provide?

First, ATSC 3.0 replaces 8-VSB with a more aggressive scheme for bit multiplexing: OFDM (Orthogonal Frequency-Division Multiplexing). This almost triples the nominal bit rate ceiling, from 32 Mbps to 90 Mbps. Of course, overhead will eat up some of this nominal 90 Mbps bitrate. But even a 40% overhead tax on 90 Mbps would still leave broadcasters with a real data rate of around 55 Mbps.

Second, ATSC 3.0 replaces the 1994 MPEG-2 compression standard with the latest 2013 MPEG-5 compression standard. The good news is that this change makes not only a 30 fps

4K UHD stream possible within the old 8-VSB transmission envelope (at 18 Mbps), but easily enables 60 fps 4K UHD (or 30 fps 3D 4K UHD) within the new OFDM envelope (at 36 Mbps).

The bad news is that, unless real OFDM bitrates can be gotten up into the 70 Mbps range (not at all clear), ATSC 3.0 is unlikely to handle even a minimal version of a future 8K UHD upgrade (or 60 fps 3D 4K UHD). Of course, 8K UHD remains a problem for the future rather than any sort of near-term concern.

Regrettably, much the same can be said of ATSC 3.0 itself. Not only is the standard not yet final as of 2016, but serious practical issues render any timeline for its future deployment highly uncertain.

Chief among the practical obstacles ATSC 3.0 must overcome is its incompatibility with ATSC 1.0. On the transmission side, this means over-air broadcasters will need to make a substantial investment in new modulation, compression, and (to some extent) transmission, editing, control and other equipment before they can deploy ATSC 3.0. On the receiving side, this means none of the 300M or so TV sets sold in the US since the digital transition (or many yet to be sold) will be able to receive an ATSC 3.0 signal. In other words, at whatever future cut-over date is set for the transition to ATSC 3.0, every set that worked up to that moment with 1.0 will immediately go dark—unless, by that time, all working TVs have dual mode capability, able to run with either sort of signal (8-VSB MPEG-2 or OFDM MPEG-5).

The bottom line here is that, while ATSC 3.0 provides a clear technical solution for broadcasting 4K UHD over air, it is less clear that it will handle even the minimal demands of a potential future 8K UHD upgrade. Moreover, the incompatibility of ATSC 3.0 with ATSC 1.0 leaves not just its timeline, but even the practicality of deploying it, shrouded in mystery.

Next time, we will turn to the challenge of deploying UHD over the wired Internet.

[10]The bulk of the hefty 40% transmission overhead penalty in ATSC 1.0 consists of FEC (Forward Error Correction) codes, which allow receivers to check the bits they receive, determine if any were somehow flipped in transmission, and, if so, correct them.

[11]Of course, the one thing ATSC 3.0 can't do is increase the 6 MHz RF channel allocated to broadcasters. For better or worse, the radio frequency spectrum is a limited natural resource—a fixed pie that, with the rapid growth of wireless devices of all descriptions, is now beset on all sides by demands for larger slices.

Indeed, as mentioned earlier in this series, with the "2GHz relocation", broadcasters actually surrendered RF spectrum to feed Sprint/Nextel's growing demand for PCS bandwidth. In the face of increasing competition for limited MHz, doubtless the best case scenario for broadcasters is just to hang onto the 6 MHz over-air channel they now have. As a matter of practical reality, keeping all of this channel for their own use may require over-air broadcasters to upgrade from badly outdated 1996 ATSC 1.0 technology sooner rather than later, simply so they can claim no one else could put their slice of RF spectrum to better use.

[12]ATSC 2.0, like MPEG-3, was a standard begun but soon overtaken by events, and eventually abandoned without issue.