Telairity Dives Deep into 4K Technology – Part 14

Comparing Over-Air Broadcasting (OAB) with Over-The-Top (OTT) Internet broadband delivery reveals contrasting scenarios of good and bad news. For OAB, the good news is the availability of a dedicated 6 MHz channel. The bad news is that's all there is and (in the face of escalating demand for RF bandwidth) all there is ever likely to be. Of course, as ATSC 3.0 proves, improvements to technology over time make it possible to do a lot more with the same fixed resources. However, the rest of the bad news for the long-term future of OAB is that all technological improvements are subject to a law of diminishing returns.

For video compression (as discussed earlier in this series), after everything redundant, irrelevant, and insignificant has been discarded, a hard floor is reached where all and only significant data remains. Past this point, every additional bit removed by continued compression must come at the price of degraded quality. Much the same can be said for data multiplexing over a fixed-width channel. The width of the pipe and the speed of light provide hard constraints on how much data can be moved through it in a given unit of time; and, somewhere before that limit is reached, the cost of cramming additional bits down the pipe must outweigh any benefit conferred by the incremental gain in available data.

ATSC 3.0 is not yet at the ultimate limit of possible improvements to compression or multiplexing, but it is far closer to those limits than was ATSC 1.0. It is certainly close enough that no further advances are now visible, even on a relatively distant horizon. ATSC 3.0 will have to carry over-air broadcasting to and, very likely, well past 2050. Which is to say, if some form of 8K UHD can be squeezed into the ATSC 3.0 envelope, over-air broadcasting will be able to upgrade from 4K to 8K UHD. Or else, not.

Turning to OTT broadband delivery, the good news is that, although broadband is subject to the same limits on compression technology that apply everywhere else, there is no hard constraint on broadband pipe size. The size of a wired pipe can always be increased, e.g., by shifting from copper to fiber optic cabling, or by adding more fibers to optical cables.

For broadband, the bad news is that the Internet is not a dedicated resource, but one that is shared, and (by definition of www) shared world-wide. With the Internet, the real constraint on bandwidth is not technology but economics. Practically speaking, a shared resource cannot be built out to the prohibitively expensive standard of maximum possible demand. Rather, it must be sized to some more affordable standard, like "peak" loading.

Peak loading is simply an estimate of worst case (highest) actual demand. Statistically speaking, even under the most favorable conditions, this sort of calculation is certain to be wrong some of the time and, under less favorable conditions, it may be wrong most of the time. But, regardless of how good or bad peak calculations may be, they are only applicable in constrained circumstances. Thus, Amazon or Netflix may understand the demand for their specific services in a specific geography, and design capacity accordingly. But the Internet as a whole is too large and various for meaningful peak loading estimates.

Rather, Internet capacity changes in a gradual and fairly regular way. In response to a steadily rising demand for broadband services, broadband providers make ongoing investments in new and upgraded infrastructure. As a result, the Internet has more capacity this year than it did last year, and will have still more next year—and every following year, for some indeterminate (but presumably still lengthy) period.

This increase in average capacity is reflected in the periodic rise of advertised broadband speeds promoted by the various carriers. Currently, for example, Comcast's least expensive plan promises to deliver an "Internet Download Speed" of "up to 25 Mbps". Or, for a higher monthly charge, customers can purchase a download speed of "up to 50 Mbps".

As we have seen, the problem with delivering 4K UHD over air is pretty simple. In 1996, ATSC 1.0 technology was sized to deliver HD video, and has to be upgraded to ATSC 3.0 to accommodate the much higher bandwidth demands of new 4K UHD. The major issues with this transition are the incompatibility of 3.0 with 1.0 (and the consequent haziness of the timeline for 3.0 deployment), and the still vague upper limits of the 3.0 technology.

Turning to OTT broadband, however, it appears the delivery system is already past the 18Mbps needed for minimal MPEG-5 4K UHD video, even in Comcast's lowest service tier, and well past that point in their higher service tiers. So, does 4K/8K UHD video actually pose any problems for OTT Internet broadband delivery? And, if so, what are they? We will pursue these questions in the next part of this series.