The Road to UHDTV: In 2020 everyone will have it … until then, there’s much work to do
March 2013
With the exception of the revolutionary move from analog to digital, television has generally evolved gradually, driven by a calculated combination of technology advances, the desire to refresh the consumer electronics market and an often industry-inflamed public demand for more and better entertainment options.

Over the years, consumers have been offered “cable-ready” devices to pick up the hundreds of channels being broadcast by cable systems and a wide variety of high-definition televisions with varying levels of pixel quality in both interlaced and progressive formats. Most recently, leveraging existing HD standards and some theatrical successes, CE manufacturers, programmers and content delivery networks have endeavored to introduce three-dimensional television (3DTV) into the marketplace with varying degrees of success.

Each step — again with the exception of the revolutionary move from analog to digital — was a gradually evolved move from the old to the new that gave the consuming public the opportunity to acclimate to new features and services while maintaining contact with and control over their existing televisions. While the industry provoked some urgency to move on to the next generation of devices, it also wisely maintained the capabilities of the existing generation of products — unlike some computer devices and operating systems which obsoleted previous generations and thrust the market into varying degrees of disarray.

Television’s next evolution, while its end result might be deemed revolutionary by some, is Ultra High Definition TV (UHDTV), the next improvement in HD. While the major standards surrounding the technology have been identified and many have been worked out, the name, oddly enough, is still in flux. For production, we refer to it as 4K; CE manufacturers call it Ultra High Definition (UHD); the Society of Motion Picture and Television Engineers (SMPTE) calls it UHDTV1 or 2160p (UHDTV2 describes 8k). For purposes of this paper, it will be labeled UHDTV or UHDTV 4K. Whatever it’s called, the first nascent iterations are expected to arrive this summer and the Japanese have moved its development onto the front burner with expectations of deployment in 2014. For the most part, based on all the involved factors, it is relatively safe to believe that full-scale ubiquitous availability won’t happen until about 2016.

The differentiator for UHDTV is the number of the screen’s pixel resolution 3840x2160, which quadruples the highest resolution 1920x1080 available today and makes it possible for a viewer to move much closer to a larger screen without experiencing picture degradation. This many pixels, even on a super-large screen of 80 inches or more, produces a much more immersive viewing experience and, from a marketing standpoint, allows TV set makers to sell bigger, presumably more lucrative screens, for smaller, more confined viewing areas. In short, by increasing the pixel count, UHDTV decreases the viewing distance and room size needed for a bigger TV and explodes the potential market for consumer electronics being sold into the residential space.

<table>
<thead>
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<th>Format</th>
<th>Resolution</th>
<th>Display Aspect Ratio</th>
<th>Pixels</th>
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The Timeline

For this year, UHDTV will be about content creation. That means Hollywood content, very high-profile rock concerts with relatively long shelf lives and other content that will still be viable in the next half decade. There will be live trials but sports, which have very short shelf lives, or other so-called live material, will not be widely distributed.

Frankly, the tools needed to make UHDTV a reality are not yet all in place. It is possible today to create a UHDTV movie with existing cameras and editing software and mastering tools. With about 13,000 UHDTV-compatible movie screens around the world, there is also a showcase venue but the home entertainment space lacks a viable mechanism to receive and view content. There are, to be sure, several short-term fixes that will allow UHDTV to invade the marketplace. Sony introduced a download services application that will be cob-blended together for next summer and Netflix demoed a UHDTV content package at CES 2013 in Las Vegas but was vague on the subject of availability. But, for the most part, the necessary pieces to shoot a piece of UHDTV content, bring it back to the studio and then distribute it across the mass media are not in place.

For UHDTV to become ubiquitous it will need to be transported across the most popular — actually, the primary — transmission methods today: cable, satellite, IPTV, over-the-top Internet and over-the-air broadcast. Best estimates are that the missing technology links to get content into homes won’t be available until 2014 at the earliest. This will mean the arrival of new consumer electronics — probably set-top boxes of some sort — to decode and display the content on UHDTV televisions.

Grass Valley’s Goals

Because our customers have asked for it, Grass Valley, a Belden Brand, has been a pioneer in the UHDTV evolution and today, based on input from those customers, we are in the process of building our first iterations of UHDTV-ready products.

No company today can operate in a product development silo and effectively meet customer demands, thus Grass Valley has been committed and active, to varying degrees, in the efforts of multiple standards organizations, including efforts by the Motion Picture Experts Group (MPEG) and Video Coding Experts Group (VCEG) to establish a Joint Collaborative Team on Video Coding (JCT-VC) that will develop the all-important High Efficiency Video Encoding (HEVC) standard and does contribute to the SMPTE who are responsible for the elaboration of standard use in the television production and the broadcast industry.

HEVC is a successor to H.264/MPEG-4 Advanced Video Coding (AVC) with an end goal of improving video quality, doubled data compression (over H.264/MPEG-4 AVC) and resolution up to 8192x4320 in the future.

Grass Valley, as a company, has successfully transitioned most of its products from SD to HD and from HD to 3G/HD. The goal is to follow that same route and transition product to UHDTV with special focus on acquisition products, routing switchers, conversion and distribution products as well as monitoring products.

Silicon needed to drive these devices should be available by the second half of this year so consumer electronics manufacturers can begin to build devices by the middle of 2014. The MVPDs — cable, satellite and IPTV providers who responsible for delivering the content to end users — will then customize those set-tops for their own systems, beta test the units and the content, then roll out services by the end of 2014 or early 2015. Even then, consumers can only expect relatively few channels of UHDTV to be on their pay TV menus with only a relatively small amount of content available on those channels.

As often happens with a technology evolution, UHDTV-capable televisions will be the first to arrive on the market. Early versions of these sets will be capable of receiving UHDTV content from Sony but they won’t achieve widespread market penetration because they will be expensive: $20,000 for a 44-inch set and $7,000-$8,000 in two or three years for most sizes.

This is not a traditional chicken-and-egg scenario because, while the transport mechanism will not be available as quickly as the content, there will be time to build audience demand via existing presentation formats such as movie theaters.

The point is that UHDTV will come to consumers in much the same evolutionary way HD made its mark on the viewing public. Timeless UHDTV content is mastered and stored today to be shown on a TV when available to consumers in three, four or five years.
The Pieces of the Transition

As stated earlier, there are a number of pieces still needed to complete a successful UHDTV end-to-end delivery/reception model, starting with a standards migration. This section details industry standards activities needed — and in the works — to make UHDTV a reality.

**ITU BT.2020**

The International Telecommunications Union (ITU) adopted ITU BT.2020 in August 2012, defining a progressive frame rate for UHDTV with an image size of 3,840x2160 pixels. The standard also defined a variety of available frame rates — 120, 50/1.001, 50, 30, 30./1.001, 25, 24, 14/1.001 but did not specify transport, metadata or audio. Also defined were bit depths of 10 bit or 12 bit and a new system colorimetry.

**SMPTE**

It’s expected that the SMPTE will update its ST2036 standard to match BT.2020. ST2036 is part of a series of SMPTE standards defining both UHDTV (aka UHDTV1) and 8k (UHDTV). Based on multi-link at 1.5 gigabits or HD-SDI, 2036 defines mapping for UHDTV up to 60 frames per second (fps) and the transport over a single or multi 10 gigabit optical link.

Other SMPTE standards include ST435 which defines UHDTV at 30 fps over a 10 gig optical link, based on a multi-link at 1.5 gig; ST2048, which vies 2k and UHDTV constraint specifically for the D-Cinema application; and ST425, a suite now under revision that covers UHDTV transport on multi 3G-SDI links.

**Consumer standard**

A number of consumer standards will be melded into the larger standardization processes, including a definition of HDMI (1.4a) that supports UHDTV at 24 fps and HDMI 2.0, set to be published in the first quarter of 2013 that defines UHDTV support up to 60 fps.

The Consumer Electronics Association (CEA), along with the European Broadcasting Union (EBU), the Society of Cable Telecommunications Engineers (SCTE) and the Advanced Television Systems Committee (ATSC) are also working to make certain UHDTV fits within the parameters of their particular technology subsets.
Fundamental Technologies

A number of fundamental technological elements are in various stages of development in anticipation of emerging UHDTV standards. In most instances, these technological advancements are being driven by a consumer electronics industry eager to move forward with a new high definition standard.

Camera and Monitors

New Super 35 mm-sized camera sensors and lenses are now available for Digital Cinema, including ones from RED, Sony and Canon. Astro, JVC and TV Logic have LCD displays for professional use of UHDTV over 4 HDMI physical links or 4 SDI cables. Sony is in production with a 30-inch UHDTV monitor that can input 4 HDMI or 4 3G-SDI.

Codecs

There are multiple production and transport codecs available for digital cinema, including the Panasonic AVC Ultra that delivers up to 400 Mb/s and the recently introduced Sony XAVC that has already been licensed by Avid and Adobe. J2K and DIRAC, by their scalability nature can be used as well in transport application.

Distribution codecs are not quite as far along with the primary piece being the HEVC (or H.265) codecs which permits delivery up to UHDTV at 60 fps. Software implementation is already available for demo and hardware will occur late in 2013 or early 2014. Mass production of silicon based on this unit is not expected until mid-2014.

It is important to note that consumer adoption and consumer delivery need HEVC so it is good news that these codecs were solidified in early 2013 enabling manufacturers to build equipment around their parameters.

Other distribution codecs in various stages of development and approval include one that delivers UHDTV at 60 fps in a terrestrial transmission scheme (demonstrated by the Korean Broadcasting System) at CES 2013. This codecs uses HEVC at 35 Mb/s to deliver DVB-T2 over a 6 MHz RF channel. It is reportedly 75 percent more efficient than existing MPEG-2 digital compression and would be a key element in easing the delivery of UHDTV content over existing transmission architectures.

Recording and Editing

Multiple recording and editing technologies are either available or are in the process of development to deliver UHDTV at an acceptable rate up to 60 fps.
Implications for Production

The biggest certainty about UHDTV is the uncertainty still surrounding many of the elements needed for commercial content delivery and reception.

Commercial live production equipment is currently in a state of flux, with equipment transitioning and some new equipment being developed and a standard has yet to be developed for carriage of live production. Live to solid state storage, a key element in non-movie UHDTV content production, is now partially possible.

There is still a need for a UHDTV system camera, production switcher, live production DVR and transport equipment although new UHDTV camera systems are under development and field trials are under way using existing cameras and equipment.

Probably most important of all — and an area in which Grass Valley is actively involved — is the infrastructure within the plant that allows the service provider to distribute and switch signals, up to the ultimate playout stage where the signal is aired with branding.

Today it is possible to go on-site and, using existing camera equipment, record live on solid state equipment. Still to be resolved though, is the development of a full UHDTV system camera so that live events like sports that are linked to the production switcher can reliably determine that all the cameras are delivering the same layers of content quality.

The Biggest Hurdle

Perhaps the biggest limiting factor on the immediate development and introduction of UHDTV is the fact that UHDTV cannot be delivered over the existing Multichannel Video Programming Distribution (MVPD) plant. There is also the need to standardize and adopt a number of new methods to deliver UHDTV via broadcast, satellite, cable, IPTV and OTT to the PC or set-top box, which, in turn, will need to be new because existing units cannot handle the new content.

The positive news is that HEVC was approved in January 2013 and will enable distribution to the residence. The less positive news is that this new codec will require a new delivery mechanism.
The Ultimate Timeline

The best thing about UHDTV is that it is not a chicken-and-egg process. Because there will be content waiting when the content creation and transport issues are resolved, there will be a ready audience, albeit a limited one because every new technology necessarily bursts upon the scene more expensive than the final mass-produced product.

It is important to emphasize that UHDTV will be an evolution, not a revolution. Consumers already accustomed to HD will gradually evolve to the more immersive, but still HD, UHDTV experience. Consumer electronics manufacturers, already mass producing large-screen HDTVs, will be able to gradually migrate over to UHDTV-capable HD units and when they do there will be content waiting and available — even if reception is, at the start, more cumbersome than the end product. In that instance, again, the UHDTV evolution will follow what has gone before: tape to DVD to Blu-ray, each improving on the other and each, at least at the start, superior to the content delivered via traditional broadcast, cable and IPTV and satellite networks.

This is an important point to emphasize because not all technology transitions have been especially free-flowing. For example, the format struggle between Blu-ray and HD DVD unnecessarily disrupted the transition from DVD to high-definition DVD, causing some content developed to develop two different pieces of hardware or hedge their bets — and their potential profits — by building for one side or the other.

3D, which is still evolving, has widespread support across the CE space and some MVPDs have begun transmitting content. The transition here has been hampered more by outside influences — the lack of widespread content, consumer desire and even the cost of televisions — than any technological obstacles. Still, the fact that 3D prevalent and popular in theaters, is experiencing difficulty gaining traction in consumer homes.

UHDTV comes to the market with content — movies that are in theaters now and can be configured for the new format. It also comes with the potential to develop new sources of content and a migratory path already experienced by MVPDs as they moved from a scattering of HD channels to dozens, perhaps hundreds of high definition programs. This previous smooth migration from SD to HD will stand the industry in good stead as it moves to what is essentially the next generation of HD.

While the transition promises to be smooth, it does not promise to be overnight. Grass Valley understands this and is working to respond quickly to a changing industry’s demands based on new technology and evolving standards.

Grass Valley already is playing a key role in the UHDTV transformation with equipment that’s needed for the TV plant to make it happen, including some existing gear that can already be used such as a routing switcher, multiviewer and distribution equipment.

Grass Valley will also play a key role in the content creation of UHDTV in the short term because it has products now that support customers’ initial rollouts.

The delivery element for Grass Valley, as for every vendor, is still in flux. While many key components are now available for use, many more will be needed — and are under development — to meet the 2014 deadline.

Conclusion

The road to UHDTV has been cleared and graded by content owners, consumer electronics manufacturers and even governments. Japan is pushing the standard to build markets for its CE vendors. It now needs to be paved with technology that makes the transition from HDTV to UHDTV smooth, quick and efficient.

It will be during this process — already in formative stages — that companies like Grass Valley will develop the tools with which a new evolution of television will be constructed.