THE AGE OF ULTRAHD

THE AV INDUSTRY IS STILL COMING TO TERMS WITH UHD, BUT THE BAR IS BEING RAISED AGAIN WITH NEW FEATURES AND THE RELEASE OF ULTRAHD BLU-RAY. KORDZ DIRECTOR DAVID MEYER EXPLORES WHAT IT ALL MEANS AND HOW TO IMPLEMENT THE TECHNOLOGY.

There's no longer any doubt about whether UHD is coming – it is.

The questions now pertain to features and bandwidth, and what will be needed to ensure it all works. How will developments such as HDMI 2.0a, HDCP 2.2 and UltraHD Blu-ray change things, and what does the future hold for HDMI and HDBaseT?

We live in the connected age, but connectivity takes many forms. What works now may not work next year and escalating formats such as UHD mean exponentially increasing data loads. It's crucial for AV integrators to stay informed and prepared in order to ride the crest of this coming UHD wave.

UHD EVOLUTION

Early UHD was a little confusing, as it came without source devices or content, and there was even some uncertainty about what to call it.

Naming convention has settled with UltraHD, or UHD for short, and content is finally on its way with the advent of UltraHD Blu-ray. The next generation is now all about technologies that make UHD better rather than just the number of pixels.

The new directive is 'immersion', for an overall superior and more realistic visual experience. This is consistent with, and complemented by, the new immersive 'object based' audio formats such as Dolby ATMOS and DTS:X.

With video it's a new set of three-letter acronyms – HFR, HDR and WCG – augmented by such terms as Rec 2020, HEVC, all protected by HDCP 2.2, and displayed with quantum dots or nano crystals.

The key to installing next-generation UHD is a proper understanding of the new features and technologies, how they co-exist, and what effect (if any) each will have on the data payload.

Understanding what will be going down the proverbial pipe will enable you to know the size, type and compatibility of pipe to install from end to end in the AV system.

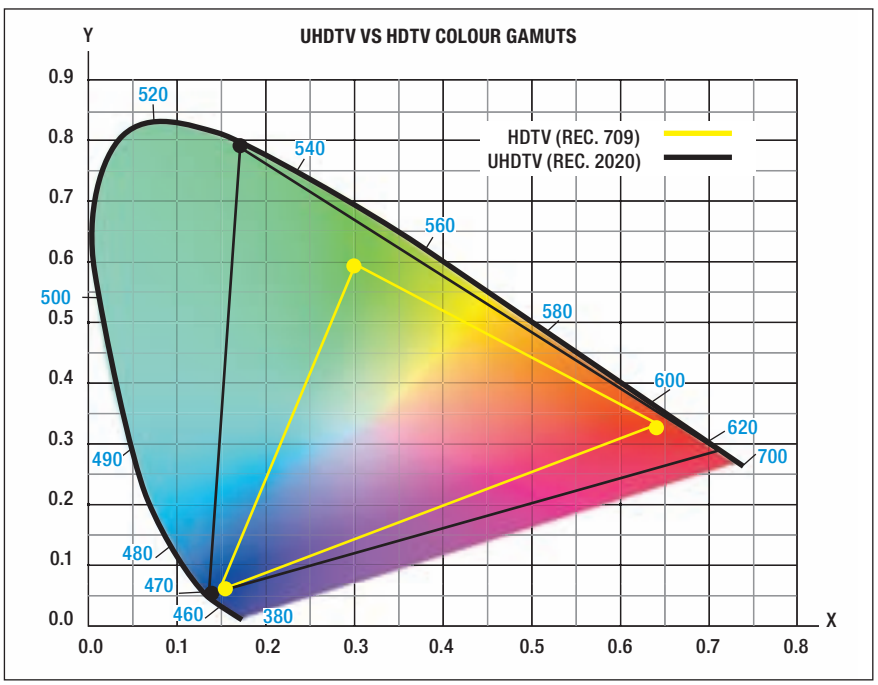

Figure 1. (Source: *The Color of 4K*, Hometheaterreview.com)

ULTRAHD BLU-RAY

Substantial portions of the new UltraHD Blu-ray format were released in May 2015, and the first players are expected to reach the market by the end of the year.

The highlight features are as follows:

- 3,840 x 2,160 pixel resolution;
- high dynamic range (HDR);
- wide colour gamut (WCG) Rec 2020 10-bit video;
- high frame rate (HFR) up to 60fps, though most movies will probably remain at 24fps;
- 4:2:0 chroma subsampling only, to minimise file sizes (something's got to give!);
- support for immersive, object based audio (e.g. Dolby ATMOS),
- new generation high efficiency video codec (HEVC) H.265 compression, otherwise even the increased disc capacity still wouldn't be enough (players will retain H.264 compression codec support for backwards compatibility with existing Blu-ray Discs);

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- 66GB dual layer discs at 108Mbps video rate, and premium 100GB triple layer at 128Mbps (compare this to over-the-top, or OTT, streaming services such as Netflix which are quoting about 16Mbps rates), so UltraHD Blu-ray should look stunning;
- HDMI 2.0 with HDCP 2.2 outputs; and,
- Digital Bridge for sharing digital content across a range of in-home and mobile devices.

Some of these features will affect connectivity bandwidth and some won't. Then there's the unresolved questions of what HDCP 2.2 means for existing hardware such as AV receivers, matrix switchers, active cable products, extenders and the like. Time to explore.

It's crucial for AV integrators to stay informed and prepared in order to ride the crest of this coming UHD wave.

HIGH FRAME RATE

HFR refers to any frame rate over 30fps, typically up to 120fps.

HDMI 1.4 originally limited UHD to 30fps, but then HDMI 2.0 increased this to 60fps. The latter can be achieved without exceeding the existing high-speed HDMI limit of 10.2Gbps if the video is 8-bit 4:2:0. However, as soon as it goes to 10-bit, and/or at 4:2:2 or RGB/4:4:4, the data rate will push past 10.2Gbps.

That would mean going past the limit of HDBaseT and into limited selections of long length HDMI cables. The good news is that most movies will probably remain at 24fps, in which case it shouldn't be an issue.

HIGH DYNAMIC RANGE

This is the latest buzzword which appears to be popping up everywhere.

It's the headline act of the recently released HDMI 2.0a specification update and a key feature of UltraHD Blu-ray.

Dynamic range refers not only to the levels of white and black, but also intensity of brightness therein.

We used to reference the contrast ratio of TVs as a comparison tool, but newer technologies such as the organic light-emitting diode (OLED) really are achieving infinite contrast, making such ratios redundant. That is, individual pixels can be in any state from completely off (absolute black) right up to new levels of the brightest white.

HDR simply means the brightness intensity can be several times higher than conventional levels.

A word on luminance. The International Standard (SI) unit for luminance is candela per square metre (cd/m^2). A common non-SI unit often used in North America is called a 'nit' ($1cd/m^2 = 1$ nit). Modern TVs and computer monitors typically output 200-400cd/m^2, with 300-350cd/m^2 being common.

Newer display technologies, including OLED and quantum dot (or nano crystals), are able to output much higher levels of light for short bursts. OLED is a direct light-emitting source that can natively achieve very high peak output levels for bright whites, while simultaneously leaving other pixels totally off. No backlight means absolute contrast.

Quantum dots comprise a new layer of tiny semiconductor particles of mere nanometres in size, which is added between a TV's backlight and its LCD screen. These particles can be activated to light up individual pixels above and beyond the backlight's white level capability. This can substantially add localised brightness per pixel, to enable short-term higher light output with greater colour accuracy.

Between these two technologies there are already displays achieving 800cd/m^2, and I've even heard suggestions as high as 1,500cd/m^2. Imagine sunlight reflecting off shiny car paintwork, chrome or glass, and the video reproduction being just as blinding, while retaining some absolute blacks in the same image.

This new dimensions of realism may have you reaching for your sunglasses while watching TV.

WIDE COLOUR GAMUT AND BIT DEPTH

The International Telecommunications Union (ITU) is a regulatory body within the United Nations that serves multiple functions.

One of its roles is to make recommendations to the video production and broadcast industries on video and colour standards to ensure consistency across products, brands and platforms.

The three main format recommendations that are most relevant in this context are ITU Rec 601, Rec 709 and Rec 2020. You often see them expressed with BT.x instead of Rec, but they are the same thing.

Each of these recommendations includes, among other things, video resolution, aspect ratio, frame rates, colour gamut definition and bit depth, and where they fit in the frequency spectrum.

Main application characteristics are:

- Rec 601 was originally issued in 1982 for standard definition TV, being 480i and 576i, as used by SD broadcast TV and DVD;
- Rec 709 came along in 1990 as the standard for high definition TV covering 720p through 1080p, and is the colour standard of the current Blu-ray Disc; and,
- Rec 2020 was released in 2012, >

The official new UltraHD Blu-ray logo.

and is the adopted standard for UHD, including UltraHD Blu-ray.

Figure 1 shows the International Commission on Illumination (CIE in French) chart, being the full colour spectrum. UHD's Rec 2020 (black triangle) covers about three quarters of the visible spectrum; regular HD's Rec 709 (yellow triangle) covers about 30%.

However, just having a bigger colour palette to choose from does not mean more colours – for that we need to increase the bit depth.

Every possible colour is determined by unique combinations of red, green and blue co-ordinates. Bit depth then determines the number of possible shades of these colours. Higher bit depth employs exponentially increasing integers: 8-bit colour supports 256 shades, 10-bit has 1,024 shades and 12-bit has 4,096 shades per colour component.

More shades means better gradations, less banding and far more realism and perceived depth of field:

- 8-bit = 256 red x 256 green x 256 blue = 16.78 million colours
- 10-bit = 1,024 red x 1,024 green x 1,024 blue = 1.073 billion colours
- 12-bit = 4,096 red x 4,096 green x 4,096 blue = 68.7 billion colours

UltraHD Blu-ray includes 10-bit Rec 2020 as the premium UHD colour space but will limit the frame rate to 60fps for data conservation. Some titles may still be released in 8-bit, as with existing Blu-ray Disc.

WHAT ABOUT 3D?

The Consumer Electronics Association specification CEA-861-F (which cross-references HDMI 2.0) and the UltraHD Blu-ray specification do not include support for 3D at UHD resolutions.

However, UltraHD Blu-ray players would be expected to support 1080p 3D possibly up to 60fps (frame packing, net aggregate 120fps). This would be at the discretion of the manufacturers and is not mandated at all.

HDCP 2.2 AND BANDWIDTH

HDCP 2.2 is the new encryption Standard mandated by the CEA for protected UHD content.

It's a new authentication protocol not backwards compatible with versions 1.x, and it even contains a locality check to ensure the receiver is within a 20ms response time. This limits it to direct real-time uncompressed connections, namely HDMI, and thereby excludes long distance and/or buffered transport layers such as IP/Ethernet.

The main issue with HDCP 2.2 is that even in a closed HDMI system it won't work on anything but new HDCP 2.2 enabled devices. It's a hardware embed, so there is no firmware update option either.

What we don't know yet is just which features might be locked down into an HDCP 2.2 environment, where lesser functionality may still be accessible through legacy HDCP 1.x connections.

In addition, a new higher level of bandwidth will be required across all hardware and connectivity in order to access the full capabilities of UltraHD Blu-ray. Here it is broken down into three key combinations through HDMI:

- **9Gbps (300Mcsc* / 1.5GHz bandwidth) with HDCP 1.x**

This is where the top end of high-speed HDMI is currently running, and it is the combo of most modern premium AV receivers and matrix switchers.

It supports things like 1080p60-3D. Although it has the bandwidth to support basic UHD, the lack of HDCP 2.2 may lead to automatic de-featuring, or this could render it inoperable for new native UHD sources. We don't know yet.

- **9Gbps (300Mcsc* / 1.5GHz bandwidth) with HDCP 2.2**

Existing maximum bandwidth combined with HDCP 2.2 encryption support will unlock UltraHD Blu-ray with 10-bit Rec 2020 HDR performance up to 30fps, or 8-bit colour limited up to 60fps, still with HDR.

- **18Gbps (600Mcsc* / 3.0GHz bandwidth) with HDCP 2.2**

This will be the new flagship level, unlocking all features of HDMI 2.0 and UltraHD Blu-ray, including 10-bit Rec 2020 colour up to 60fps with HDR (which is 11.14Gbps), and possibly even 12-bit 4:2:2 if that happens to come along.

It also supports UHD60 8-bit RGB for high-end graphics applications. The latter two formats top out the pipe bandwidth at 17.82Gbps.

*(*Mcsc = Mega characters per second per channel, where one character = 10 bits.)*

In short, to enable the full expected feature list of UltraHD Blu-ray and other native UHD sources, all devices – including source and display, and everything in between – must be able to support HDCP 2.2. There is no converting with a magic box in between. It's bad news for consumers who will have to shell out a lot more money, but it's good for the industry.

HDBASET COMPATIBILITY

With HDBaseT there is good and bad news.

The good news is that HDBaseT is

inherently HDCP agnostic, as it doesn't decrypt or decode the HDMI signal. It just serialises and modulates the raw encrypted data stream. It then passes through the HDCP keys untouched for the source and sink (or repeater) to negotiate and allow operation.

The big exception to this is with devices employing HDBaseT that do decrypt and decode the HDMI data. This is not done by the HDBaseT chip, rather by an ancillary part of the circuit in the same box.

Examples include any devices that need to get to the audio, such as an AV receiver or any device with audio breakout. Or it might be to access the video to perform scaling or other processing, or add OSD.

Any such decoding means that HDCP keys are required. If it's not version 2.2, then it won't work for HDCP 2.2 protected content.

There is one other big 'gotcha' with HDBaseT. It won't work past 10Gbps, so even if HDCP 2.2 can be passed, it will still be limited to the formats mentioned in the second point of the previous section (i.e. no 60fps with 10-bit Rec 2020 colour).

Even the latest Colligo family of chips with the option for a fibre backbone cannot (at this time) support past 10Gbps.

For installations requiring beyond 10Gbps, the options are more bespoke high-end native HDMI or some fibre solutions (non-HDBaseT).

THE FUTURE

With UHD still in its infancy, there's already a lot of talk about the next step - i.e. 8K.

The Society of Motion Picture and Television Engineers refers to UHDTV1 (loosely termed 4K) and UHDTV2 (8K).

Futuresource Consulting director Sarah Carroll says: "With 8K on the horizon, there is speculation as to whether the window for 4K will be short lived."

At four times the resolution of UHD, 8K seems well beyond the scope of current delivery methodology.

CES 2015 had several 8K displays being demonstrated, but the connectivity profile would have to completely change in order for this to become a consumer option.

For example, HDBaseT can't even support UHD60 with 10-bit colour, and HDMI caps out at UHD60 12-bit 4:2:2. An 8K display would need HDMI up around 45Gbps using current methods. It's more likely that it would have to look at a compressed delivery system such as H.265 over the wire and let the display do the heavy lifting.

But this is merely speculative, and it's hard to predict the next steps. Where will this end?

CONCLUSION

UHD will become a vastly more attractive value proposition once UltraHD Blu-ray is launched.

Offering up to 128Mbps video rate quality with an unparalleled feature set, it will far exceed any other form of native UHD source.

However, with inhibitors of bandwidth expectations and HDCP 2.2 compatibility, the implications for consumers and integrators will be demanding.

And this all starts now. The connectivity profile installed in a home or commercial space now will determine whether it can support these new features next year and beyond. Hardware can always be changed later, but cabling often can't.

To be safe, choose options that can support at least 9Gbps to ensure up to UHD30 with 10-bit colour and HDR support. Check that any active components can support HDCP 2.2.

If you can find support options, or those that at least show promise of being scalable to 18Gbps, then you will be doing your clients a great service by unlocking the potential for UHD60 in all its HDR 10-bit ITU Rec 2020 glory.

Throw in some OLED or quantum dots, and serve with stunning object-based audio for a fully immersive experience. CH