

THE DPP'S

10

things

YOU NEED TO KNOW ABOUT
ULTRA HIGH DEFINITION

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digital production partnership

INTRODUCTION

You may have heard of Ultra HD, UHD-1 or 4K, all names for a new high-resolution TV format. If not within a production office, then perhaps you'll have seen it in a retail outlet. Unlike the early days of HD, where you had to go to high-end outlets such as Harrods or John Lewis to see one of those new-fangled plasma flatscreens, your audience can now get sight of UHD in just about every electronics shop.

As you dive into the detail you'll hear about bigger screens, larger pictures, a better audience experience, larger files and more complicated workflows. And then somebody will tell you we don't just need more pixels, we need better pixels! What is a "better" pixel anyway?

Just as with any new technology there is a lot of information and quite a lot of hyperbole surrounding UHD. But be in no doubt: UHD is going to happen. More and more producers will start to produce in UHD. The only question is when.

This guide is designed to help you understand what UHD is and what you'll need to think about when the time comes to take the plunge into this new format. It will explain UHD-1, why you might use it and how it could make a difference to your audiences. It'll highlight areas you'll need to think about when considering UHD in shooting, post production and delivery. We'll consider the various changes that make up a UHD picture, and also the audio that goes with it.

Right now, there are a lot of questions still unanswered around UHD. As the standards emerge and more real-world experience is gained, this guide will be followed later in the year with a more detailed production workflow from the DPP, which will fill in some of the currently-missing pieces.

More pixels

Ultra High Definition is, just as it sounds, an evolution of High Definition. High Definition brought us larger pictures, with a resolution of 1920x1080 pixels. UHD takes that further with 3840x2160 pixels in UHD-1, and a further enhancement called UHD-2 with 7680x4320 pixels some time in the future.

Those with speedy mental maths skills might notice that UHD-1 has 4x as many pixels as HD, and UHD-2 has 4x as many again, for a total of 16x as many pixels as HD! UHD-2 is a number of years off, although the Japanese national broadcaster NHK intends to launch a service in 2018 in time for the Tokyo Olympics in 2020, and they are already working hard to understand how it might work in a typical production chain.

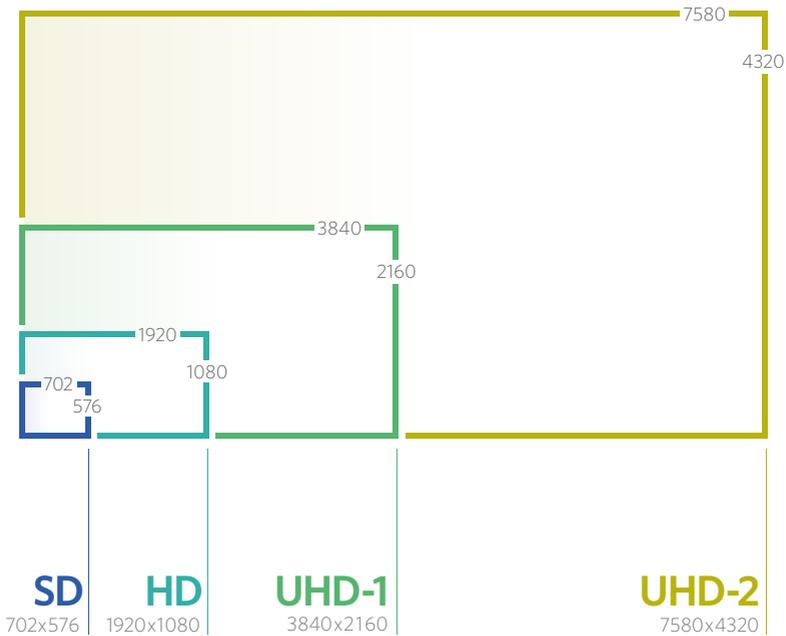
It's worth noting that the term "4K" has been quite widely adopted in the consumer electronics industry, which is confusing because strictly speaking 4K is the movie standard, with slightly more pixels at 4096x2160. (It also has a different colour space from UHD – more on that later.) The chances are that unless you are producing for Digital Cinema, 4K will not be required. However within the TV industry the terms UHD, UHD-1 and 4K are, unfortunately, often used interchangeably.

Despite all the noise around 4K, if you saw a 4K image beside an HD one you might wonder what all the fuss was about. Indeed research with

MORE PIXELS

consumers finds that most people struggle to tell the difference between the two formats on screen sizes under 56". But while this first wave of UHD is just about providing more pixels, there are other developments to the UHD picture that are altogether more exciting: these are the ones that provide a picture that is not only *bigger* but *better*, as we'll see in the next three sections.

Frame Resolution



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More frames

A TV camera works by capturing a number of pictures, or frames, each second so that when they're played back they give the perception of smooth motion. With larger screens and bigger pictures, viewers become more aware of some of the side-effects of this, such as smear and flicker. Therefore UHD generally needs more frames to ensure that fast motion still looks good.

Standard Definition and most High Definition television uses 25 frames per second. To make matters more confusing, TV has historically used a technique called interlacing to show each frame in two halves, or fields, so that the flicker rate is 50 flashes per second. (This is partly because the human eye requires a minimum number of flashes per second to avoid seeing visible flicker, and partly to make motion appear smoother.) UHD will do away with interlacing, and will have the capability to display 50 full frames per second, or possibly even 100 or more.

The challenge with higher frame rate (or HFR as you may see it called) is that it can change the "look" of the programme. For some content types, such as fast-moving sport, the increased clarity is generally positive, but for content such as drama, some people subjectively prefer lower frame rates. Film is generally 24fps, which is why lower frame rates are often referred to as having a "film look". You might want to check out the high frame rate

MORE FRAMES

version of *The Hobbit* which polarised critics – some loved it, others hated it... and this was only 48fps! The jury is still out, and therefore there may be an element of editorial decision-making involved. It's certainly worth considering that not all your audience will feel the same as you, and so any choice is a compromise.

It is worth noting that most modern televisions can already accept 50fps content at their inputs, and most UHD TV sets actually display 100fps by using internal processing to artificially create the extra frames. However the availability of TVs that can handle input signals with very high frame rates (100fps or more) may still be some time away.

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More dynamic range

One way to create better pixels is to increase the *Dynamic Range*, or the amount of difference between the darkest pixels and the brightest pixels.

Our eyes perceive the world around us with an enormous range between the very dark and the very bright. However currently TV systems make a fairly poor job of representing what we really see, with a much smaller range between the dark and the light. We've got used to that of course, but UHD will be able to portray a much larger dynamic range to make everything look more life-like. This will also help us to overcome muddy blacks and blown-out whites.

High Dynamic Range, or HDR, is gaining a lot of interest at the moment, but it'll be gradual in its arrival. Like most new TV technologies, its adoption will need changes in cameras (though some high-end cameras are capturing higher dynamic range already), editing software, the broadcast chain, set-top boxes and TVs themselves. There is a great deal of work taking place in the standards bodies to determine the technical details of how HDR will be implemented. It's a well-understood set of technologies though and will come along soon. Indeed, some movies and online content are already being created in this format.

MORE DYNAMIC RANGE

Everyone who sees pictures with HDR seems to love them. And when combined with higher resolution you get a UHD picture that both producers and consumers immediately recognise as better. The consumer electronics trade shows are already showing off TVs that display UHD with HDR, and these will become widely available to consumers over the coming year. We expect these displays to appear in living rooms in significant numbers by around 2017.

More colours

Another area where our current TV system is not as good as real life, is in its representation of colour. The range of colours that can be displayed in a current TV picture is much smaller than the range your eyes can see. The set of colours that can be represented by the TV system is called the *colour gamut*.

UHD has the potential to represent a much broader range of colours by using a wider colour gamut. This means that the pictures will look more vibrant and engaging, and will look much closer to an accurate representation of the world around us.

The standard currently being developed is called *ITU-R Recommendation BT.2020* so you may sometimes hear people talk about “Rec 2020” or “2020 colour”. You may also see the abbreviation WCG – Wider Colour Gamut.

Much like HDR, Wider Colour Gamut is something that many people immediately recognise as being an improvement on the TV pictures they’ve been used to.

Who's doing it?

UHD may be bleeding edge technology, but a number of programmes are already being made in this format. Although it is early days, it's not that different from the early days of HD. In reality, making a programme in UHD is just like making a programme in standard definition or high definition: you plan your shoot, get a camera, view and log rushes, edit, colour grade and finish. And don't forget that any UHD you deliver now will probably only be "Quad-HD" - in other words 4x as many pixels but without the enhancements of higher frame rates, higher dynamic range, or wider colour gamut.

You may have heard of companies like Netflix and Amazon commissioning UHD content for their online TV services. Most broadcasters cannot yet transmit UHD content, so requests for UHD are mostly coming from co-producers, either directly or through distribution companies like BBC Worldwide, ITV Studios Global Entertainment and Sky Vision.

Some productions are also starting to capture in UHD even if their deliverable remains HD for now. They are doing this for two reasons. The first is to increase the future value of their content: this is especially worthwhile for genres such as Natural History that have strong archive value. The second reason is that shooting high resolution images has benefits in its own right: for example it is possible to zoom into a UHD-1 image to get a full quality HD image. Post production techniques such as image stabilisation also often

WHO'S DOING IT?

work better if they have more pixels to play with (though they'll take longer to process). As a result, some productions are even shooting particularly high value or tricky sequences in 4K or higher resolution, but doing the rest of their production in HD.

A few broadcasters are now starting to move to UHD, with BT Sport launching Europe's first UHD channel at the beginning of August 2015. Sport is of course largely broadcast live, so there may be fewer post production concerns, but all the elements in the signal chain (switchers, routers, graphics and more) need to be UHD.

You can be sure that others will follow soon enough. Terrestrial UHD is a long way off, so as more and more broadcasters begin to offer UHD services they will come through satellite, cable or internet (OTT) channels, and online on-demand platforms.

Who pays for it?

The first UHD programmes are tending to be co-produced pieces, so it is difficult to know if broadcasters will be prepared to pay any budget uplift for UHD commissions. The cost of making UHD content will initially be higher: even if your chosen cameras can shoot it, the ingest and storage costs will be higher due to the larger files, a UHD display will be required, and you'll need powerful and modern post production kit.

How much impact all these elements will have on overall costs will vary depending on the context in which the UHD production is made. For those who own up-to-date equipment, and are able to 'clear down' the rushes quickly from their servers, the up-front cost increase may be relatively modest. But if you are creating a UHD production in a modestly equipped environment with material that has to be stored for a long period, it could be expensive.

The good news is that, just like with HD, the cost will come down over time. Eventually we'll probably be using UHD for everything, just as HD replaced SD.

If you're commissioned to produce UHD today (even if the delivered programme is HD), then depending on the broadcaster you are delivering to, you may need to ensure any cost uplift over and above HD is accounted for and paid for separately. As much as that is a chore, it will be helpful for both you and the broadcaster to fully understand the costs and balance that against any additional value for your audiences.

How do I shoot it?

There are plenty of UHD cameras available already, so the challenge won't be finding one, it'll be finding *the right one*. Many of the UK Broadcasters have been working with the EBU (European Broadcasting Union) to make camera choices simpler. While the camera can be one of the most confusing and sometimes emotive parts of the technology chain, you can get clear guidance on which devices meet the necessary criteria.

EBU R118 ([details at https://tech.ebu.ch/camtest](https://tech.ebu.ch/camtest)) provides guidance on different tiers of HD cameras based on their suitability for TV production, and it's been updated for UHD with UHD Tier 1 and UHD Tier 2. You'll need to check that the resolution of the camera meets the delivery requirements you've been given. You can use R118 as a reference with a co-producer which will make sure everyone understands the requirements.

It's important to note that most UHD cameras have 4K sensors as they are used for cinema as well as television. Currently it is often better to use cameras in 4K mode and crop the 4096 pixel wide image to 3840 pixels for television delivery.

Most UHD cameras have the option to record in proprietary RAW formats. This maintains maximum picture quality, but the files are very large and this

HOW DO I SHOOT IT?

will be considered in the next section. Some also now have options to record high dynamic range and wide colour gamut using compressed video codecs. This results in smaller file sizes, though you'll need to ensure that your post production process can handle these files.

If you are also shooting for High Dynamic Range, shooting in RAW affords maximum flexibility as it will allow you to maintain all the information required for making technical decisions about finishing in HDR later in the process. Seek expert guidance for the particular camera you have selected.



How do I store it?

Four times as many pixels will potentially mean four times the storage space, which can become a problem when working with UHD. Also, as we mentioned in the previous section, many UHD cameras work in RAW formats which capture the full output of the camera sensor with little-to-no compression, making the files even bigger.

You'll need to consider storage requirements at all levels, from camera cards to edit storage and through to archive.

Many of the camera manufacturers provide alternative codec/format options, usually based on the same AVC format as AS-11 DPP, though usually taking up at least 3-4x as much space. The successor to AVC, known as HEVC, will help bring these sizes down, but it's currently not very widely supported, and it takes huge processing power to encode and decode, meaning it won't be a viable option for some time.

Nonetheless, your UHD footage and programme masters are very valuable and so good storage is crucial. Camera rushes should be backed up and smaller working copies (proxies) will usually need to be made - just like in the early days of HD. The high data rate of UHD files usually means that even fast edit storage will struggle to keep up, so an offline/online edit workflow is likely to be needed.

How do I edit it?

Proxies for editing need to be high enough resolution to see if the original UHD shot is usable. HD (1920x1080) may be good enough to see if something needs to be checked in the original file. Some editing systems now support editing UHD using new formats such as DNxHR or AVC-based codecs. However, as it is still early days for UHD, and until industry standards are agreed for compressed programme exchange, uncompressed finishing is usually preferred. There are already several devices that are capable of conforming, grading and mastering uncompressed UHD files.

Do remember that as the files are larger they will take longer to move around and process. This means that proxy generation, effects rendering and transcode time will go up compared to HD. Any computer system (editing, grading, transcoding) which handles UHD content will need to be modern and fast.

As with any edit, time spent to view, log and organise rushes will save you time in the edit, and will save you money on storage if you can keep only the good footage on *online storage* (fast and expensive), and archive or delete the rest. It may be best to use a post production supervisor who can take the content from the camera rushes though to the deliverables, liaising with your post production providers and any other relevant parties. As always, good communication and early planning are key.

HOW DO I EDIT IT?

As ever, we mustn't forget the sound. It's likely that UHD will stick with the existing 5.1 surround sound system and stereo for now. Tests have been done with UHD pictures and 22.2 sound (yes, that's 22 speakers and 2 subwoofers), but that's probably not going to work for the average home! A new concept called "object based audio" allows your equipment at home to render out the most suitable sound based on your listening environment. It has the potential to be amazing, but it's still under development and also requires our audiences to purchase yet another piece of equipment, so is unlikely to make it to production soon.

How do I deliver it?

Although most broadcasters aren't currently transmitting UHD, they can store UHD programme masters, so if you are producing a programme in UHD you will probably want to deliver it in UHD!

There is no standard format agreed for programme delivery to UK broadcasters in UHD yet. The DPP is working on such a delivery format right now, and it should be published by the end of 2015.

Until a standard delivery format is available, you will have to agree a format with your broadcaster. Formats currently in use include XAVC, or for image exchange within post, Digital Moving-Picture Exchange (DPX). Your post production supervisor and post production providers will be able to advise on this.

As with most stages of the process, the larger file size will have an effect on delivery times too! If you have a good network link, you may be able to transfer an AS-11 DPP HD file in around real-time, but a UHD file will take considerably longer.

WHAT'S NEXT?

There is still a lot going on in the development of UHD. The standards for capture, delivery and broadcast of UHD content are being considered by standards bodies and industry organisations, from SMPTE to AMWA, the DTG and of course the DPP. Some standards, such as IMF are already in use by the movie industry, but don't yet meet the needs of broadcast.

The TV manufacturers have been shipping 4K displays with the 'more pixels' approach for some time now, and at 2015's NAB trade show there was a lot of buzz around HDR. The same is broadly true for cameras, with 4K resolution available on a huge range of devices, and higher dynamic range on some high-end models which shoot in a RAW format.

Content delivery in UHD is starting to happen from suppliers like Netflix and Amazon, with broadcasters such as BT Sport about to begin services too. The international trade press is reporting new UHD services launching in different countries on an almost weekly basis - with those services tending to come from satellite and internet (OTT) providers. Progress on colour gamut, dynamic range and frame rates has been slower, but the formation of standards will be key to driving this process.

The DPP are working on a standard for delivery of UHD content to UK Broadcasters which will address these areas. It will be published by the end of 2015, and will give clarity on the agreed technical standards for delivery of UHD content.

There are also a large number of areas of the UHD workflow which are still being worked on and improved. Some of the key areas are:

WHAT'S NEXT?

Up-conversion: you may be allowed to include a certain amount of non-UHD material in a UHD programme, but you should check with your broadcaster to confirm how much.

Down-conversion: most of your audience will watch your programme in HD today, and so the programme must be down-converted from UHD. The technology to do this is still developing and there are no agreed standards to give firm guidance at present. Some motion compensating processing should usually be used.

Colour space conversion: if your UHD has a wider colour gamut than HD, then conversion to HD must produce natural flesh tones and should not clip or slice colours that appear outside the HD colour space. This may mean a manual re-grade from UHD to HD.

Codecs and formats: as you'll have found in the earlier sections of this document, the lack of standards here causes some challenges. However, it's likely to be one of the quickest areas to be resolved, at least for programme delivery.

The publicity around UHD is growing, led often by the television and camera manufacturers who want to sell their newest products. But the benefits to creatives and to viewers will be genuine once the challenges are ironed out. The DPP predicts the real take off of UHD is likely to happen from 2017 onwards.

As with any new technology, there will be bumps along the way, but can you remember a time when people weren't seeking to make television sound and pictures better? Quality has always been something that excites us all.

Glossary

2020 colour	See Rec 2020.
4K	A picture format with around 4000 pixels on each line. Originally referring to digital cinema at 4096 pixels wide, but now often used to refer to UHD TV at 3840 pixels wide.
8K	A picture format with around 8000 pixels on each line.
AMWA	The Advanced Media Workflow Association. A body who develops broadcast standards and who published the AS-11 delivery specification.
AVC	Advanced Video Coding. Also known as h.264. A family of video codecs using a specific set of methods to compress video signals. AVC-I class 100 (used for DPP HD delivery) is a member of the AVC family.
Codec	Coder/Decoder. A method used for encoding (and usually compressing) video.
Colour Gamut	The range of colours able to be displayed by a particular format.
Conform	Re-link the edit sequence to the high resolution master media after a low resolution edit.
Data Rate	The amount of data used per second of video/ audio (e.g. 5Mbps = 5 megabits of data per second of video).

Glossary

Down-conversion	The process of producing lower-resolution pictures from higher-resolution ones.
DPX	Digital Moving-Picture Exchange. A 'digital intermediate' video format most often used for visual effects and grading.
DTG	The Digital Television Group. The UK collaboration centre for innovation in digital media technology and home of the UK UHD Forum.
Dynamic Range	Amount of difference between the darkest pixels and the brightest pixels in an image.
EBU	The European Broadcasting Union. An industry body bringing together broadcasters from across Europe.
HDR	High Dynamic Range (see Dynamic Range).
HEVC	High Efficiency Video Coding – also known as h.265. The next generation of video codecs, following on from AVC.
HFR	High Frame Rate 25p The “film look” that most dramas use now. 50p 50 full frames per second (instead of traditional TVs 50 fields per second), which is better quality for sport and other fast moving action. 100p Truly high frame rates will be 100fps or 120 fps.

Glossary

IMF	Interoperable Mastering Format. A file format used for mastering and exchange of content, especially in the US.
Interlacing	A technique used in TV to make movement look smoother without increasing the number of frames, by splitting each frame into odd and even “fields” which are recorded and displayed alternately.
ITU	The international standards body (part of the United Nations) that sets the world’s television standards and manages the allocation of broadcast frequencies.
Object based audio	A method of recording audio which treats each source of sound as its own “object” which are mixed by the receiver into as many channels as makes sense for that device (perhaps one for your phone, but 20 for a cinema).
OTT	Over The Top. A way of delivering content over a broadband connection.
Pixels	Picture Elements. The individual dots that make up an image.
Quad-HD	The simplest form of UHD-1 as it has no HFR, HDR and only the current HD colour. As the name implies, it’s 4x the resolution of HD.

Glossary

RAW formats	Video formats used by cameras to record the full output of the image sensor without processing.
Re-grade	The process of changing the colour balance of pictures, perhaps to make use of a wider colour gamut.
Rec 2020	(Full name ITU-R BT.2020). A standard developed by the ITU, allowing a greater range of colours to be displayed to viewers.
Resolution	The number of pixels used to make up an image.
SMPTE	The Society of Motion Picture and Television Engineers. A standards body that sets international standards for movies and television and how the signals are transported.
Transcoding	The process of translating video from one format to another.
Up-conversion	The process of creating larger resolution pictures from smaller resolution ones.

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