

UHD

**PRODUCTION  
WORKFLOWS  
GUIDE**



digital production partnership

# INTRODUCTION

Back in 2012, the DPP published *The Bloodless Revolution*, a workflow guide aimed at programme makers, technology vendors and service providers, to assist them with the transition from tape to file-based working. Unsurprisingly, technology has continued to evolve, and we once again find ourselves at a point of technological change – the move from High Definition (HD) to Ultra High Definition (UHD).

What makes this change interesting however is that it's the first change to happen in a fully file-based world. The DPP has already published a short primer on Ultra High Definition, called *10 Things You Need To Know About UHD*. This sets the scene and should help with the basics. However production teams are now starting to work with UHD, so it's time to examine the workflows in a little more detail. All UHD references in this document relate to UHD-1, or 4K as it is sometimes called. The other type of UHD is UHD-2, sometimes called 8K. While many of the programme making processes involved in this document will relate to both UHD-1 and UHD-2, 8K carries so much additional data we feel that it will stay safely in the realm of large screen entertainment for some time, and is unlikely to be used for broadcast for many years yet.

So what's changed since *The Bloodless Revolution*? Unlike the transition from tape to file, which affected

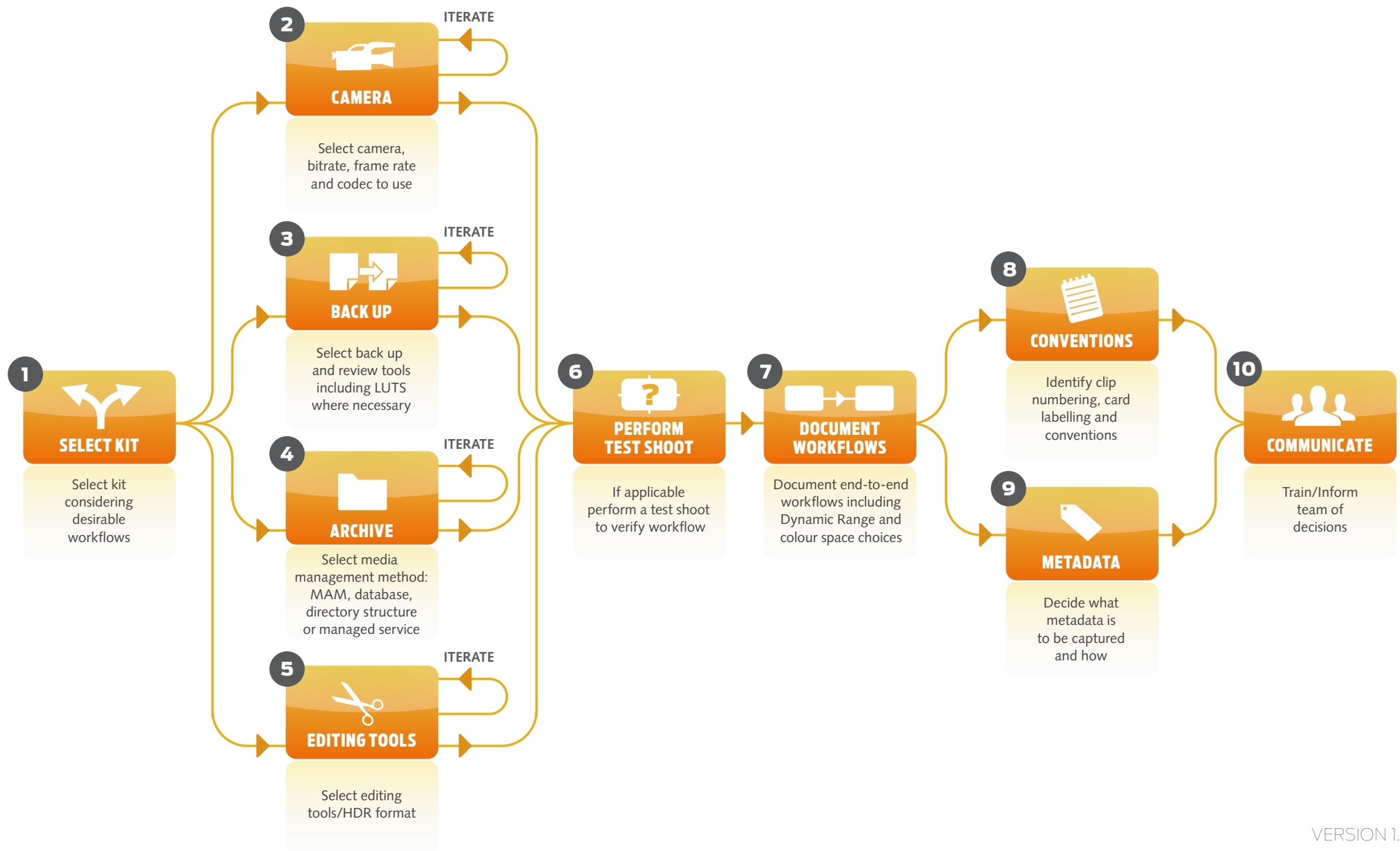
huge areas of the production process (right down to the make-up of production teams) this change is more evolutionary. Whereas *The Bloodless Revolution* was full of talk of new terms like "data wranglers" and "metadata", those concepts are now firmly entrenched in the production community. So the good news is that with UHD the basic "rules of production" remain the same. You still need to plan your production, manage your rushes, post produce and deliver your programme. *The Bloodless Revolution* is still an excellent introduction to these topics. In fact the only real difference is that with UHD you'll have a few more choices as to how to tell your story. It's about new technology bringing new creative options.

As with *The Bloodless Revolution*, this document will focus primarily on pre-recorded long-form workflows, though some of it will apply to live and other content too.

# THE WORKFLOW



# PART 1: PLANNING





## BEFORE YOU START

There are many clichés that seek to remind us how important planning is: we've probably all heard the one that goes '*if you fail to plan, you plan to fail.*' Annoyingly most clichés contain real truths – and this one is no different. Planning has been crucial to file-based production since it began, and UHD is no exception. The need to plan starts well before you get a camera out of the box or make that call to the hire company. In fact, there are even more planning considerations in UHD than in HD, and time spent at the planning stage will reap benefits later in your production process.

Perhaps the first question you should ask yourself is why you're making UHD. If you've been commissioned to make a UHD programme, the answer is obvious, but you may also occasionally choose to shoot in UHD even if delivering in HD. One reason you may consider doing this is because the very high resolution of the UHD image allows your editor to pan and zoom around within the image. If they do this they are no longer using the whole UHD frame at its full resolution – which is fine if the deliverable is an HD programme, but will mean that shots treated in this way are no

longer considered UHD. (On the face of it, working within the UHD image like this is not allowable if the finished product is commissioned to be UHD. In practice however your commissioner may allow a certain amount of content to be treated this way if it is of creative benefit – much like HD programmes can sometimes contain some SD material.). Remember that even if your final programme is delivered in HD, shooting UHD will have an impact on the storage you need for your rushes, the amount of time it will take to move material around, as well as those new creative decisions in the edit where you choose which part of the picture you want to work with. There will therefore be a cost and time impact, and you also need to be careful about zooming-in too far, to ensure you always output a full HD resolution picture.

### FRAME RATE CHOICE

Unlike standard definition and high definition, the UHD specifications do not use interlaced pictures. This affects your output, because interlacing is part of what created the traditional "video" look that we generally associate with news or live programming. UHD only exists as a progressive format, and (ignoring

fast frame rate acquisition for slow motion purposes) can be acquired in one of two ways: 25p (25 frames per second, progressive), giving it a traditional "film" look; or 50p (50 frames per second, progressive) giving it its own look, sharing something in common with both film (as it's progressive) and video (as it displays more pictures per second). Generally speaking, fast frame rate acquisition is very good for reducing motion blur and strobing effects caused by fast shutter speeds, and is therefore useful for genres such as sport. A drama may initially feel a little strange at 50p, although over time we do expect more UHD acquisition to migrate to 50p. An early user of high frame rate in the film world was Peter Jackson's film *The Hobbit*, shot at 48 frames per second instead of 24 frames per second. It's worth a watch as it's got a very different feel about it – an examination of the differing views of the film critics is also enlightening!

It's also important to understand the impact of shooting 50p on your other deliverables – most of which will be 25 frames per second and either HD or SD. Shooting more frames every second usually means the camera's shutter is open for a shorter time for each frame. Should



a particularly short-length shutter be used then the video may exhibit flicker when converted to lower frame rates. It is possible to add some clever interpolation to the conversion, but the results won't be perfect. Conversely, if you shoot at 25p, you can convert to 50p for transmission with no noticeable impact on the image, though you won't get the smooth motion of shooting at 50p.

You will probably want to test your frame rate choice prior to your shoot, to make sure it's giving you the effect you want editorially and that it will be fully supported through your post production process. As with all acquisition, once it has been filmed, there is no going back. Recording twice as many frames per second will also use twice as much storage, so this should also be borne in mind.

#### **OTHER CONSIDERATIONS**

Of course, you mustn't forget audio. We are expecting UHD to be delivered with 5.1 surround sound and stereo for the foreseeable future, so the considerations

are much the same as with HD. There will probably be more 5.1 surround commissioning in UHD though, so if you've never recorded surround sound before you may wish to seek advice from experts. Some future UHD systems have even investigated 22.2 surround sound – yes, 22 channels plus 2 subwoofers! – but don't worry, that's not going to be here any time soon and will most likely sit in the realm of specialist film theatres for some time to come. What is coming however, and much more appropriate to our audiences is Object Based Audio. It's very early days but this is a new system which renders the audio at the receiver in line with the viewing environment. It also has the scope to change elements within the sound mix to better suit the viewer – for instance if the viewer finds the music distracting, they would be able to turn that down without affecting the speech. Brilliant!

A couple of other areas for consideration are sets and makeup. It's worth checking whether the increased resolution of UHD shows up any defects or joins as we found similar issues when moving from SD to HD.

Makeup and prosthetics may also need more attention as well. Do ensure you have the appropriate monitoring to enable informed decisions to be made. You don't want to get to that big scene with a full cast and crew to find that you need to go hunting for a paintbrush!

#### **DPP RECOMMENDS**

It is very wise to prepare a document for your commissioner that describes how you plan to use UHD and what the 'look' will be. For instance, how much content will be true UHD resolution? What will the frame rate be? You may want to submit a test file which illustrates your intended look. It could prevent issues later – especially while we haven't yet got a common understanding of UHD among everyone in the process.

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2

## SELECT KIT

UHD kit is evolving. That means that there will continue to be improvements over time, which is great. However it also means that you'll have to jump in and decide what to use when you're ready to shoot, whilst understanding that there'll be something new and better down the track.

The camera choice is one of the most important, and certainly one of the most emotive, technology choices. Don't forget the kit you will be using to back up and archive, particularly as file sizes are much larger. You will also need to consider on-set review, which may require format conversion and UHD monitoring kit. You should also make sure your kit is high dynamic range (HDR) capable if that is one of your agreed deliverables.

Post production is affected too, with big file sizes and new colour and dynamic range options to be considered.

## CAMERA

### WHICH CAMERA?

Although the camera can be thought of as an easy place to start, it is part of an end-to-end chain, so it should not be considered in isolation. The final choice should not be confirmed until you and your commissioning broadcaster, plus any other suppliers who are involved in your workflow, are clear about the workflow.

As with HD, the EBU usefully provides a set of 'tiers' for UHD cameras, which describe which types of camera are suitable for what type of content. The details can be found at <https://tech.ebu.ch/camtest>. This will help both you and the commissioning broadcaster to understand which camera you are filming on and what mode of shooting is best to use. There are two tiers of UHD camera, broadly based on the resolution of the sensor. Tier 1 describes cameras that offer an output resolution greater than 3840×2160 pixels (the full UHD frame size), and Tier 2 cameras offer a resolution between HD (1920×1080) and 3840×2160 pixels. It's worth bearing in mind that the EBU website is quite technical, and may be hard to understand, so do take advice from the broadcaster to make sure that the camera is technically suitable for the strand or service into which you are delivering. The type of programme you're producing

and the budget you've been allocated may well affect whether the broadcaster requires use of Tier 1 cameras or if they're happy with Tier 2. And although there are a number of Tier 2 cameras, Tier 1 cameras are few and far between. So if you need a Tier 1 camera then make sure you have got one booked well in advance.

One important thing to understand is the difference between single chip and three chip cameras. Single chip cameras have one sensor that captures red, green and blue, by using a "Bayer pattern" of pixels, each of which sense one colour. Three chip cameras split the light using clever optics and send it to 3 separate sensors, one for each colour. Many single chip cameras will quote a high resolution, but have to go through a process called "de-bayering" which reduces the resolution you get at the output. This process doesn't happen with three chip cameras, so the resolution you're quoted is the resolution you'll get. Single chip cameras usually have large sensors, which give a short depth of field, which is often desired for drama. Most 3 chip cameras use smaller sensors, which put more of the picture in focus and this is often useful for sport, factual, entertainment or news.

An approximate rule of thumb with single chip cameras is that, to be in Tier 1, the horizontal pixel count (that's

## 2

**CAMERA**

(continued)

the bigger of the two numbers) should be above 5760. This means that after de-bayering (which divides the resolution by 1.5) you'll still have a resolution higher than 3840.

It's also worth noting that some of these cameras have the ability to "overcrank" the frame rate for slow motion capture. This is a really useful feature, but on many cameras, as the frame rate increases, the resolution goes down. So if you are not careful a very fast frame rate might render your UHD camera into an HD one. Be careful to check this out, and if in doubt, shoot a test.

**DPP RECOMMENDS**

Take advice from co-producers, your commissioning broadcaster and others before you and your DoP decide which camera to use.

Of course, a camera choice isn't just about the pictures it produces. Don't forget that you're going to need a camera that's ergonomically suited to the type of work you're going to be doing, and you'll need a great viewfinder to see those UHD pictures. Many modern cameras include functions like viewfinder zooming for

focus-checking, and this can be very important: think how awful it would be to discover your pictures are out of focus when you get them into the edit suite!

**WHICH RECORDING FORMAT?**

UHD recording formats are evolving. It is most likely that you will record either in a proprietary RAW format onto dedicated drives or to a more compressed codec such as ProRes, DNxHR or XAVC. Please note that RAW recording often takes up much more disk space than other codecs. Some RAW formats are compressed, but even with compressed codecs you will be storing much more data than you did for HD, so cards or drives will fill up quicker. The implication is that cards may need to be cleared for re-use more often, and there will be a corresponding time impact, as back up copies will take longer to create. As a rule of thumb, a UHD recording at 25p contains 4 times as much material as an HD recording. A UHD recording at 50p is double that – 8 times the size of HD. That's pretty big given that many programme genres already record RAW or use a high bitrate codec. These are not trivial numbers and although new recording formats and more efficient compression formats such as HEVC will develop over time, it's safe to say that the new UHD world is simply bigger – much bigger – and will stay like that for a while.

The good news is that it's all technically possible, but will have an impact on time and equipment. In short: working in UHD won't fit easily within an HD budget.

**WHICH CAMERA SETTINGS?**

There are two varieties of "4K" resolution, and the first setting you'll need to check is that you have the right one selected. UHD TV uses a frame size that is 3840 pixels wide (giving a picture that's 4x the size of HD), while movies use a picture 4096 pixels wide. Bigger isn't better in this case, so remember to use the TV resolution when making TV programmes in order to prevent lengthy and expensive frame-size conversions before editing begins. (Of course, if you're shooting for film too, your choice may differ.)

There is an increasing industry view that for UHD to prove successful to audiences, the increased resolution needs to be supplemented with additional features, such as HDR, WCG (defined in ITU-R BT.2020, often shortened to BT.2020 or Rec 2020, and referred to as WCG) and for certain genres high frame rate (HFR). These features are covered in our earlier guide, *10 Things You Need To Know About UHD*, and it's extremely important to ensure that these are considered as part of the camera decision. Many people in the industry are



## 2

## CAMERA

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using a new UHD mantra: not just *more* pixels, but *better* pixels. In the event you record without these “better pixels” you will be acquiring in the simplest form of UHD, called Quad-HD.

In order to get better pixels, you ideally want to record using HDR and WCG. HDR captures more detail in highlights and shadows. It is often stored using a logarithmic scale, although RAW formats may capture HDR in a traditional linear scale. This logarithmic recording will then be graded and output in the correct HDR standard for delivery to the broadcaster. There are a number of manufacturer-specific logarithmic implementations already in use, such as Log C and S-Log, all of which can be adapted to suit your HDR output. There's also ongoing work that may set more widely accepted standards that can then be adopted by manufacturers and broadcasters. Until then it is very important to be clear what your finishing process is going to be, and that you can definitely transform your camera's logarithmic pictures into the HDR format you are required to deliver.

The advantage of using HDR is that it allows for the capture of a greater exposure range, or number of aperture stops. This exposure range gives programmes

a great look and it will help the audience feel much more immersed in the subject. The bad news is that HDR cannot be displayed correctly on a conventional HD monitor and requires a Look Up Table, or LUT, to be applied to your monitor. The Film and Drama world is very familiar with LUTs, but many parts of the TV world are less familiar, so for some of us this will be new. Be aware therefore that correct review and monitoring of your pictures on set will need appropriate monitors with the right LUTs so you can see a good representation of the pictures you've shot.

It's worth noting that in order to see the extra detail in HDR pictures, viewers will need a new television (although the main HDR formats are backwards-compatible and will be viewable in standard dynamic range on existing displays too). So do expect to see consumer displays come onto the market that mention HDR as part of the marketing message. Of course it has to be a form of HDR that is compatible with what the broadcaster is transmitting, and a decision on the HDR standard is still to be made. We expect that for the foreseeable future there will be two types of HDR that consumer sets will have to cope with, most likely SMPTE-2084 (PQ) and ARIB STD-B67 Hybrid Log Gamma (HLG).

This treatment of colour and range, almost as entities on their own rather than part of a single video signal, is often referred to as “Colour Management”. This umbrella term is commonly used in feature film and high-end post production areas. It ensures that the colour that you see on different devices is consistent, and also that any conversions you do which involve colour, such as through the use of a LUT, have the correct output. All this ensures your rushes look right on the edit monitor; and that your graded finished programme looks right on the screen at home.

## DPP RECOMMENDS

Wherever possible, you should shoot UHD using RAW or Log, as this allows you to produce HDR or SDR outputs. HDR is expected to become standard in the near future, and creates a much more compelling picture for the audience. Some early-adopter broadcasters may currently commission 4K resolution without HDR, but that will become less common over time. To maintain the best future value of your pictures, you want them to look as good as possible.

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## BACK UP & ARCHIVE

The back up and archive processes for UHD are no different from working with other file-based formats. However, as UHD pictures are usually much larger than HD, special consideration needs to be given to the time taken to move material around. We would suggest that the interfaces between storage systems should be Thunderbolt 2 or USB 3, both of which offer fast data rates. You will of course be able to work with slower interfaces but moving material around will take a very long time – older USB 2 interfaces for example will prove painfully slow. Don't forget that both ends of the cable (e.g. the card reader and the computer, or the computer and the hard drive) need to support faster speeds – a USB 3 drive plugged into a computer with only USB 2 will run at slow USB 2 rates.

Of course, you will also need to be very clear how much back up storage you need, which will depend on how much you're shooting and the camera codec you've chosen. This increase in storage needs will significantly impact on many parts of the production process and therefore needs to be very carefully thought about. As a rule of thumb, the smallest UHD file at 25p is four times larger than an HD file. What that means is four times the storage for your main and

back up recordings, and four times as long moving material about. 50p recordings will take twice as much space again.

When planning, don't forget that the extra time taken for processes like back up isn't just a technical consideration – it'll impact on your staffing. Will there be someone on-set with time to do the back up? Can you get the cards back to base quickly enough to ingest and create a back up? Planning these things up front will make everyone's life calmer and simpler.

## EDITING TOOLS

UHD editing tools are developing, with all the major NLE (non-linear editing) and finishing software now supporting UHD at least to an extent. The choice of tools may be determined by your post production provider, but consideration should be given to the type of HDR you are using and the edit system's ability to work with it.

Unlike HD, where many programme makers are used to working with full resolution media in many edits, the larger file sizes of UHD mean that the edit will most likely be carried out using a lower resolution proxy of some type – perhaps HD! It's unlikely that you will be able to get alignment between the camera codec and the edit codec but, as some edit systems prefer one codec over another, do pick the appropriate one to which to transcode (e.g. Avid's DNx for MediaComposer or ProRes for Final Cut Pro) as this will make sure that your edit goes as smoothly as possible.

The specifics of generating proxies and conforming or re-linking at the end of the edit will be much the same as these workflows in HD and SD. As ever, the larger files will mean that processes take longer and you'll need more storage. One new consideration is that if you shoot in HDR and/or WCG, your edit proxy may need to use standard

5

6

7

## EDITING TOOLS

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dynamic range and standard colour gamut (BT.709 rather than WCG BT.2020). If this is the case, the transcode to an edit proxy will require the rendering of a LUT (a Look-Up Table) to make the pictures look correct – if you don't apply a LUT your proxy pictures look flat or dull, with an undesirable colour cast.

It's in the grade that the final colours and dynamic range will come to life. A LUT essentially applies a basic first-pass grade; this will get you 80% of the way there, but a full grade is more important than ever in UHD – especially for high end content. It goes without saying that you'll need a grading suite which is fully HDR and BT.2020 capable, and a colourist who's used to working with UHD.

Monitoring is the final, critical piece of the puzzle. There's no point in having this great dynamic range and colour space if you can't see what you're working with! Finishing suites will need monitors that support not only UHD resolution but also HDR and BT.2020 colour (at the time of writing, there are no monitors which can display the full range of BT.2020 colours, but many are very close, and full BT.2020 monitors are expected to become available soon). Your edit suite may also benefit from such monitors – although if your craft editor is working with HD proxies and standard dynamic range, this won't be necessary.

## PERFORM TEST SHOOT

One of the principal challenges with shooting UHD is that, at the time of writing, some of the standards have not been fully agreed by the standards bodies such as the EBU and SMPTE. The DPP delivery standard will get you most of the way there, but it has some options that you and the commissioner must choose between. You'll need to agree which format of HDR you will be delivering (likely to be set by your broadcaster) and which frame rate you'll be using (an editorial choice that you may get to make). It is advisable to ensure that the list of final deliverables, post production workflow, and camera choices are agreed in writing with the commissioning broadcaster – including whether you are delivering a single UHD version, or UHD and HD versions. It is crucial you agree how each of these versions will be created as budgets may limit your ability to create two separate versions.

It also goes without saying that all your deliverables should also be agreed with your production team and your suppliers and partners. It may be a good idea to perform a "test shoot". In a test such as this you shoot a sequence, post produce and deliver it, so that you can be sure your production team and suppliers are comfortable with the process and your broadcaster is comfortable with the results they receive.

## DOCUMENT WORKFLOWS

As with HD, it's important to document your workflows so everyone understands them. These should be agreed with all relevant parties, including the production team, post house, and any other suppliers. Additional information for UHD will include what type of HDR you're using, and whether extended colour or high frame rate are to be part of the final programme deliverables. As it's unlikely any programme will have only a UHD deliverable, you should document how and where any conversions or re-edits to HD or SD are to be carried out.

### DPP RECOMMENDS

It is imperative not only to document your workflows but to document who will do what, and what kit you plan to use. Ensure all your key craft talent have understood and bought into the plan. Producing in UHD is a new skill, and it has to be a team effort. You could use this document as a guide for how you prepare your workflow document, using for instance, those diagrams on pages 3, 12, 18 and 25.

8

9

10

## NAMING CONVENTIONS

The use of naming conventions to identify cards, drives and clips is just as important as ever. It's very important to have a consistent approach to this. You'll want to have a standard way to indicate whether material is original camera rushes, proxies for review, or other assets, and (for proxies) whether it has a LUT applied or not.

### DPP RECOMMENDS

The secret lies in setting up the cards and cameras to apply as much useful technical metadata as possible right from the start, and then having the ability to relate clip names to a shooting diary, report or logging sheet.

## METADATA

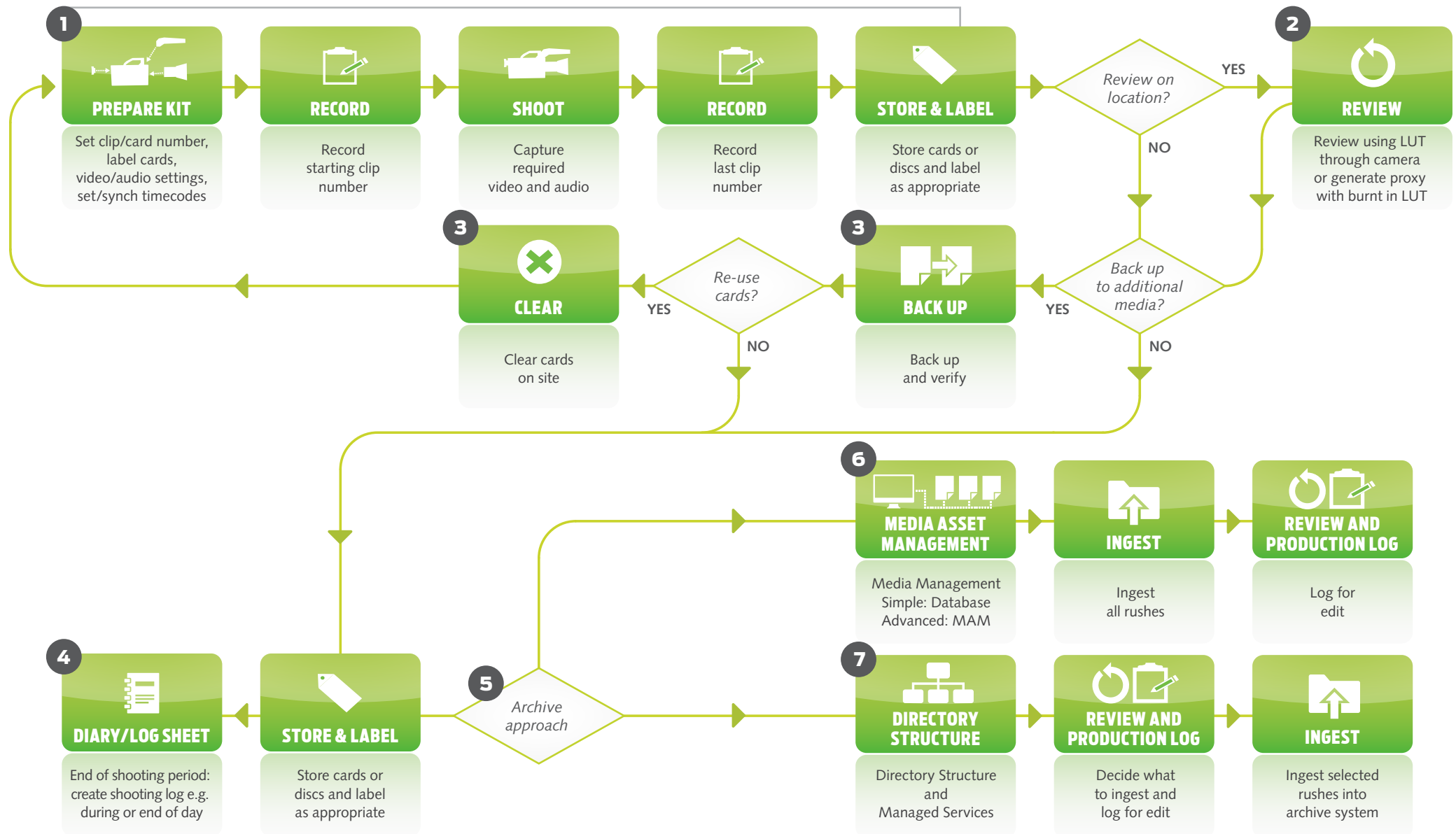
There is very little change to the metadata we use in UHD. There is more technical metadata stored in UHD files, which makes features like HDR work correctly, but you won't need to worry about this metadata; you may never even see it! You'll also have LUT files, which are a type of metadata too. The editorial metadata used for DPP delivery master files is the same in UHD as in HD, and the metadata you use for logging and organising material in your production process will work the same as ever.

## COMMUNICATE

The planning work is only worthwhile if it is adhered to, and shared with all parties throughout the production process. As UHD is relatively new and there are a number of potential pitfalls, we would suggest you set up some type of structured documentation to ensure your team understands your planning decisions and why it's important to adhere to them. If your team haven't worked in UHD before, you may also need to arrange some training, to make sure everyone knows what they're doing.

It's particularly important for broadcasters and facilities to understand your plans, especially as UHD deliverables will sit alongside HD and perhaps SD deliverables, which require re-edit or conversion. Use of standard industry deliverables will help, but sharing planned workflows, including the time and storage that's been allocated, will help understanding and confidence.

# PART 2: RUSHES MANAGEMENT





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## BEFORE YOU START

The workflow around shooting is primarily about rushes management. Many production companies are already comfortable with this area and as a result it is likely that they will already have their own way of doing things. The basics of these need not change for UHD, but there may be some new considerations to take into account.

The first element of the shooting workflow is of course shooting the content. Depending on the kit used, the next main element is whether and how to back up, and also whether to re-use cards on location. The last element is how to archive the rushes, and this is also a factor of the archiving technology in place. Each of these elements will be affected by the fact that UHD has larger files that use more storage and take longer to move and process. Reviewing footage on location does become a little more complicated when using HDR, as you may need to generate proxies with LUTs on-set, so we'll also consider that in more detail.

## THE SHOOT

During the shoot, the team should follow the naming conventions set in the planning stage, and follow the checklist below as they prepare and set up their kit in line with the agreed plans:

- Set clip/card number(s)
- Label and number cards according to specified conventions (card labelling is often referred to as physical metadata)
- Given that files are very large, ensure there are enough cards (and location back up drives, if you are using them). We would suggest you use newly formatted cards daily to avoid timecode conflicts.
- Prepare camera and audio settings, including video codecs, HDR type, wrapper/container, progressive, audio codec, bitrate/sampling rate
- Set timecode and synch timecodes between cameras

Depending on the codec choice you've made at the planning stage, you may be retaining full flexibility by recording the un-altered output of the camera sensor (when shooting RAW), or you may be burning in a 'look' in the camera. However, this latter option should not be considered best practice as although the "burn-in" will

save you from worrying about LUTs when reviewing your footage, and will save you cost and time in colour management, as it's irreversible it will limit your creative freedom and negate some of the benefits of using UHD.

### DPP RECOMMENDS



If you do burn in a 'look' we'd highly recommend a test shoot to ensure the result looks good. Also allow enough headroom for some grading revision later in post production.

### WHAT TO SHOOT

Production teams already know what material they plan to acquire. The risk with UHD is that you run out of storage, so be extremely careful to shoot what you have agreed and not more than you need. Overshooting can have a terrible cost and time impacts later in the process. More footage means more time required to review content, more storage, and more time required for processing in post production. Do remember that if you arrive at your post production facility with much more material than what was agreed, your costs will increase significantly.

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## REVIEW

The biggest question at this point is where to review your rushes on location. Location review is generally regarded as a good idea, though it may depend on the genre of content, and whether you'll have the opportunity to re-shoot if you find any problems. With the larger pictures created by UHD, it becomes more important than ever to ensure that things like focus are correct, so at least a brief review of your content is recommended where possible.

If you have recorded UHD with HDR then you will have new challenges: large file sizes mean you may get dropped frames if your playback equipment isn't powerful enough; and the picture may not look right unless you have the ability to generate a LUT to make the 'look' correct.

There are a number of approaches to these challenges. One is to bring a dailies review system onto location. There are a number of systems on the marketplace and, although not the cheapest option, these have the advantage of not only being able to generate a LUT to allow you to check picture quality, but also can be automatically set up to provide QC and back up. They run on any well specified PC or Mac.

Another way is to simply have a monitor on set with a LUT that can show the pictures correctly, and then to handle the other processes separately. If your budget is really tight and your edit facility is nearby, then you could forgo all of those and wait for the edit proxy to be generated at the post production house. In this case, it might be possible to use some basic software on-set, often provided by the camera manufacturers, to do a sense check on the footage to ensure correct framing and content, even if you can't see the final 'look'.

### DPP RECOMMENDS

Do not go into your shoot without some form of rushes review mechanism in place – even if it is only for the early part of your shoot.

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## BACK UP AND CLEAR

It goes without saying that it's important to back up rushes. This is something we've all grown very used to in the file-based world. Whether this is done on location is likely to be related to the proximity of the editing facilities or production base. With the larger file sizes associated with UHD, you may find that your budget may limit the number of camera cards you can carry. This limitation means your back up process must be carried out more frequently. We suggest you make at least two verified copies and by verified we mean a checksum should always be used. You will need to take into account the amount of time required to do this, and it is important to use drives with faster interfaces – such as Thunderbolt or USB3. A named individual, with clear responsibility and who is trained and competent should be assigned this task, and they should also let the crew know when material has been verified. If backing up on set, we do not recommend that all the copying is left to the end of the day, because it takes a significant amount of time. Lots of file copying by tired staff is a recipe for disaster.

It is important to check insurers' terms as to the acceptability of your back up methods and the number of copies required. Some vendors have an insurance-approved location back up system with card verification.

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## BACK UP AND CLEAR

(continued)

Once the rushes have been backed up the next stage is to transcode to an edit format – assuming you are editing using a proxy. We might have thought we'd seen the end of the offline/online workflow, but the file size and bandwidth of UHD brings it right back – at least until recording formats and compression schemes improve. And when you create that offline proxy, make sure you apply a LUT so that the proxies look correct on an edit monitor. Make sure you don't convert your original rushes however as you will need them for the final grade. There are two ways of approaching this situation: you can apply the LUT to the proxies on the fly, although this can make your edit system sluggish; alternatively the LUT can be permanently applied to the proxies by rendering a new file. If the proxy you generate on-set will be used for the offline edit, then you'll need to check with your post production provider to ensure you produce an appropriate format. You may need a dedicated member of staff (a data wrangler or DIT) to manage the process of backing up rushes and creating proxies.

## DIARY/LOG SHEET

There really is no change here. Just as when working with an HD file, you will get great benefit in post production and when archiving if you carefully document what you've shot and where it's stored.

## ARCHIVE APPROACH

Once the UHD rushes have been acquired and backed up they can be archived in a number of ways, just like HD. Broadcasters who are planning to build up a UHD archive are likely to have a Media Asset Management (MAM) system into which to put the UHD material. But many production companies and facility houses may find it more difficult to make the investment required to cope with the size of UHD files. These companies may instead use magnetic tapes or optical media, which can work if they take care to maintain links, folder structure and the all-important naming conventions. They may also use removable hard disk drives, but, as the DPP's *Guide to Digital Archiving* makes clear, this is a far more risky way to store material over the long term.

Although cloud based storage is getting cheaper, the size of UHD material means that cloud based storage may not be a viable commercial option for many companies today. The upload times for such large files may also be a major constraint. We can expect both these factors of cost and upload time to improve over time however.

## DPP RECOMMENDS

Have a plan before you start production to identify material to keep for the long term, and material to delete. UHD footage takes up a lot of storage, so you only want to keep the very best, and most valuable, of your rushes.

For a more detailed discussion of archiving of all kinds of content including UHD, *The DPP Guide to Digital Archiving* (available to DPP members) is a useful reference.

[www.digitalproductionpartnership.co.uk](http://www.digitalproductionpartnership.co.uk)



6

7

## MEDIA ASSET MANAGEMENT

Typically all content is ingested first and then reviewed within the MAM system – just like with HD. The content being reviewed will be a proxy, generated by the camera or by the MAM on ingest. As such, any colour management, such as applying LUTs to the proxies, should be considered; you'll want to make sure that anyone viewing the proxy is seeing the content as intended!



As it's early days for UHD, you may find that your MAM cannot cope with the file formats used for UHD. DPX encoded HDR, for example, is not yet widely supported, and this could leave you with drives sitting on shelves that you cannot work with. If in doubt, speak to your MAM vendor, as support is growing all the time.

### DPP RECOMMENDS

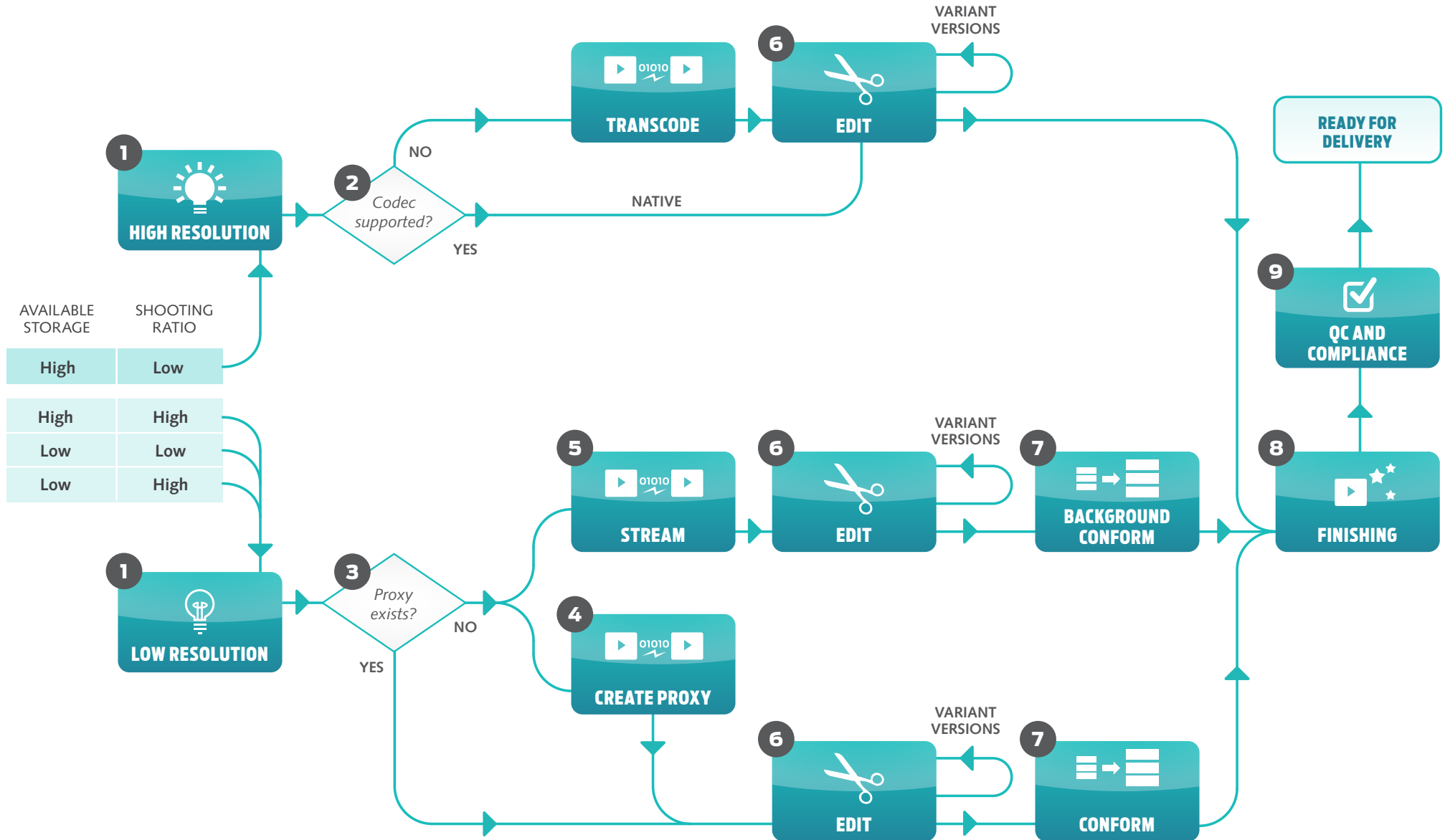
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## DIRECTORY STRUCTURE

The use of directory structures on LTO or hard disks will by now be familiar to most production companies, and the need to carefully index the contents using a spreadsheet or database is as important as ever. Just as with MAMs, be careful to ensure that any proxies stored are easily viewable. UHD formats are still evolving of course, so don't forget to consider how you'll play back your files in ten or twenty years' time. One downside of RAW codecs is that if they're proprietary to the camera manufacturer. You may be reliant on that manufacturer to supply playback software, although many third-party products such as editing software can also play many of the common RAW formats.

| ACQUISITION LOCATION/STUDIO  |   |  |   | EDIT PREP   |  |  |  |
|--|---|--|---|---|--|--|--|
| CAMERA/CARD FORMAT   | CODEC                                       | FIELD/STUDIO BACK UP                         | METADATA ON CARD  | BASE BACK UP  | RUSHES WIPING  | TRANSCODE TO EDIT CODEC  | LOGGING/ DESKTOP EDIT  |
|  <p><b>VIDEO</b></p> <p>Choice of file-based camera</p>             | <p>Codec on camera including HDR format</p> | <p>Choice of back up device if required</p>  | <p>Minimum technical metadata on original card format</p> | <p>Longer term back up, possibly on a MAM system</p>                        | <p>Protocol for wiping original cards (may happen before Base Back Up)</p> | <p>Transcode to edit codec and apply LUT. May in future be possible to edit using acquisition codec.</p> | <p>Lower resolution possibly remote or cloud-based editing</p> |
|  <p><b>AUDIO</b></p> <p>Integrated or separate audio recorder</p> | <p>Audio codec</p>                          | <p>Integrated or separate audio recorder</p> | <p>Likely to be technical metadata</p>                    | <p>Longer term back up, ideally associated with video if not integrated</p> | <p>N/A</p>   | <p>Ideally keep audio in high resolution format</p>  |  |

# PART 3: POST PRODUCTION





## BEFORE YOU START

Post production was heavily impacted by the move to file-based working, and particularly by the choice of camera and codec selected in the Planning stage.

For the smoothest HD workflow it is usually recommended that you shoot in a codec that is natively supported by your NLE. Unfortunately it's unlikely that this will be a widespread workflow in UHD for the foreseeable future; so it may be necessary to transcode to another format for your edit. Your finishing suite may need to support the original codec, however.

### DPP RECOMMENDS

Shoot in a codec that is natively supported by your NLE.

Up to now, the choice as to whether to perform a high resolution or low resolution edit has typically been determined by the amount of footage and the availability of storage for editing. Of course it's not just the amount of storage that's important, but the ability of that storage to provide data fast enough (the 'bandwidth') to work with multiple UHD video streams

in the edit. If you have the budget then you might consider working at full resolution in UHD, but the cost of storage will be high and your NLE will need to be able to work fast enough to support such big files. It is much more likely that in the early days of UHD a proxy workflow will need to be followed. As technology develops this may change.

Regardless of which workflow you adopt, the use of HDR will mean you have to change how you view your content. You will most likely need to start using a LUT to display the image correctly on a screen. Unless you have an HDR monitor in your edit – which is currently expensive – a conversion is needed to make the HDR signal appear correctly on a standard edit monitor. This HDR signal conversion is simply some maths applied to the file, and this is what is known as a LUT. You don't need to apply the LUT to the rushes themselves as this will limit your grading options later on, instead you can just apply it to the proxy in order to ensure the image looks correct in the edit suite.

## HIGH/LOW RESOLUTION EDITING

Over a number of years there has been an ongoing debate about whether the decreasing cost of storage means programme makers should now simply work with high-resolution "online" material. This often works very well in HD, though the "offline" process sometimes needs to be retained for productions with a very large volume of rushes.

UHD drives storage volumes up significantly, and although we expect file sizes to reduce, processing power to improve and bandwidth to increase, we anticipate that the requirement to use proxies when craft editing in UHD (other than for live/as-live/near-live content) will continue for a significant period of time. In addition, one of the benefits of UHD is HDR, and unless you have an HDR monitor, the material needs to be processed with a LUT so that it displays correctly on an edit monitor. It's easier and simpler to do that with a proxy, saving the high resolution UHD material in its native form for the grade.

### DPP RECOMMENDS

It's better and easier to edit using HD proxy files. The programmes can then be conformed, graded and finished using the UHD master files.

2

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## HIGH RESOLUTION EDIT

As indicated above it's unlikely a UHD edit will take place using the native camera files because the files are very large and require lots of very fast storage. This will become easier over time, though even then it may prove preferable to use an edit-friendly codec to assist with speed of manipulation and to aid the creative process. Avid, Adobe and Apple all have early implementations of UHD codecs. Apple use a high bitrate ProRes, Avid have DNxHR and Adobe have implementations of native camera files. Should you decide to work in high resolution, do remember that if you have shot HDR/RAW, then your rushes will need to be re-rendered with the LUT in place, leading to a significant increase in cost and time.

### DPP RECOMMENDS

If you do need to work with full resolution material, we suggest you consider using HDR monitors to negate the requirement to render out a LUT. This approach is also suitable for sport or other fast-turnaround programming.

## PROXY BASED EDIT

Depending on your Media Asset Management solution, proxies may have already been generated on ingest. Alternatively, some cameras can automatically generate proxies, however, just as with HD, this may not always be useful. If you're using multiple camera brands on your shoot you'll end up with multiple different proxy formats, and this can cause challenges in the edit. You will have enough to think about when filming UHD, so the additional complexity camera-generated proxies may be a step too far.

You may find it easiest to generate proxies specifically for the post production process.

## LOW RESOLUTION PROXY GENERATION

Working with low resolution proxies may prove to be the best balance between bandwidth and storage as well as providing a smaller file with which to apply a LUT. Traditional proxy formats such as Avid 10:1 won't be good enough to see the detail in your UHD pictures however. We would therefore recommend that the "low resolution" edit, as odd as it sounds, takes place at HD resolution or above, giving you the opportunity to judge critical focus – something that will be critical as audiences move to larger screens.

### DPP RECOMMENDS

"Low resolution" editing should be done at HD resolution or above, in order to judge critical focus.

The proxy format you choose may also need to take into account the frame rate you're using. For example, Avid's DNxHD 36 doesn't support 50p material, so you'll need to use the newer DNxHD 75 or DNxHR codecs instead.

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## LOW RESOLUTION STREAMING

*The Bloodless Revolution* discussed then-new products such as Adobe Anywhere, Avid Media Central and Quantel Qtube, which allow you to edit your material remotely using streaming technology. Although they are becoming more commonly used, these products are still maturing. Your ability to use them successfully for UHD will depend on your chosen tool's ability to use UHD source material to generate HD streams for you to edit with. We expect common use of this option may be some way off for UHD especially as UHD streams will require significant internet bandwidth.

## EDIT

After choosing to edit with the high or low resolution media, the craft editing process has not significantly changed for UHD. Although some craft editors are now comfortable with also finishing the programme, we would suggest that where UHD is concerned, and particularly with the addition of HDR, a specialist colourist will be required in the finishing process.

## CONFORMING

Once the edit has been completed, the low-resolution media can be re-linked to the high-resolution media ready for the grading process. This is a largely automated process, provided you've planned your media management carefully and stuck to good naming conventions.

As you will be working with much higher resolution files, do expect the conform to take much longer than when working at HD, especially if working with 50 frames per second material or sequences with multiple video layers. You'll also need to ensure you have sufficient storage for this stage of the process.

## 8

## FINISHING

Grading is perhaps the part of the post production process most impacted by UHD. As part of the planning stage you will need to understand which version of HDR you will be supplying to your broadcaster, as it will define the type of LUT (Look Up Table) you put into your grading monitor and the levels to which your colourist can work. It is likely you will be asked to deliver HDR in either Hybrid Log Gamma (HLG), SMPTE 2084 Dolby PQ, or, if you are delivering to a movie theatre, DCI-P3.

Each of these HDR formats requires a different LUT so that your colourist can grade to the dynamic range required by the broadcaster of the programme. At the end of the grade the colourist will then render out the finished programme to the required colour space, codec and resolution.

The addition of HDR to the grade means that your colourist will have a greater “palette” to work with. The down side is that the grading system will behave a little differently, so give them enough time to familiarize themselves with the system. They will find they can “push” HDR UHD images much further than normal HD images; so to get the best result a few hours extra will pay dividends. Nonetheless, early indications are that although the colourist will need some time for

familiarisation, once the HDR grading technique has been learned, the time taken for the editorial element of the grade is not expected to be significantly more than for HD (although render times may be longer).

Don't forget your graphics and captions. It may sound obvious, but these will need to be produced/rendered at the same resolution as your video, so your graphics software will need to be able to produce UHD. They'll also need to be rendered in the same colour space as your video to ensure they look good with your pictures and given time and budget considerations please check with your commissioning broadcaster how this should best be done. Moving graphics must be rendered at the same frame rate as the video; 50 frames per second will of course take longer to render and produce bigger files than 25 frames per second. Do bear in mind the speed of any moving graphics when delivering at 25 frames per second. Anything which moves too fast, or has too much movement between frames, will cause more juddering than when delivering at 50 frames per second or when delivering interlaced.

Finally, you may need to consider deliverables that aren't in UHD – this should be discussed with your broadcaster at the start of the process. It is possible that

initially you will be required also to provide HD masters of your programme. This potentially means conversion from UHD, 50p pictures with HDR to HD, 25i pictures with no HDR. A reduction in resolution is a relatively well-understood and automated technical process, but changing frame rate is complex, and you'll need to ensure you use good quality conversion. Producing standard dynamic range outputs from an HDR source is still quite tricky and unfortunately the most reliable method is currently still to have your colourist perform a manual re-grade. Separate deliverables will of course also require their own time for rendering and QC. It may be worth considering a mezzanine master. This is likely to take the form of a graded, or perhaps un-graded version of the programme from which versions can be generated without re-conforming/consolidating every time. Your post house should be able to advise.

## DPP RECOMMENDS

Ensure you have agreed a full list of deliverables for your commission from the outset and then speak to your post production company about the best way to achieve them.



## QC AND COMPLIANCE

QC and compliance processes were one of the most significant changes that came with the move to file-based working. The DPP published guidance on Automated and Visual Quality Control; and slowly but surely, production and post production companies have got used to the new ways of working. QC is of course vital to ensure that the video and audio of the final programme, together with its various versions, are appropriate for the commissioning broadcaster.

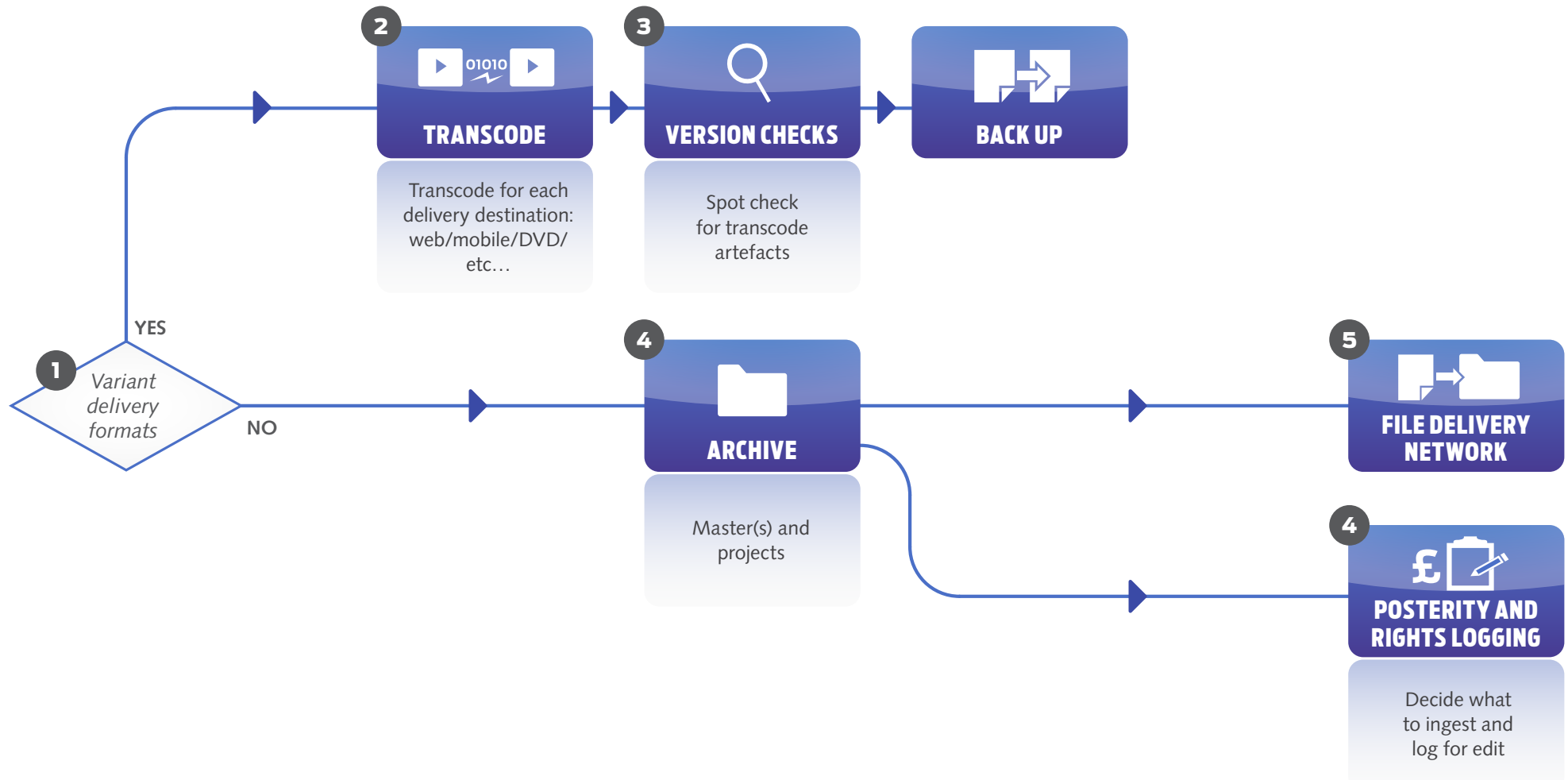
The DPP QC guidelines have not yet been updated for UHD, and so in the early days, you may need to communicate with your commissioning broadcaster to ensure that what your delivery will meet their needs. It is not expected that the QC criteria will change significantly for UHD – other than to reflect the new technical standards, such as ensuring your video is legal within a BT.2020 colour space for UHD, rather than the R.709 space used for HD. One significant area of QC testing is of course photosensitive epilepsy (PSE) testing. This is an Ofcom requirement, and no new guidelines have yet been issued for UHD and HDR. The DPP will provide further guidance as soon as any is available.

As with all areas that require files to be processed, AQC will take longer and/or require more processing power for UHD files compared to HD. If you're delivering HDR, your visual QC will need to be done using HDR monitoring. Compliance viewings will also need HDR monitoring – or to have a LUT applied in order to look correct on an SDR monitor.



|  |  | CRAFT EDIT - VIDEO      |  |   | FINISH              |                         |                             |  |
|--|--|-------------------------|--|---|---------------------|-------------------------|-----------------------------|--|
|  |  | CRAFT VIDEO EDIT SYSTEM | CODEC  | CONFORM/ RELINK                                   | AUDIO TRACKLAY      | DUB                     | GRADE                       | FINISH & LEGALISE  |
|  <p>VIDEO</p> |  | Choice of craft edit    | Edit proxy with LUT applied. May alternatively be acquisition codec if NLE allows. | Relink to nearline if editing in lower resolution |                     | Video taken from Craft  | Grading systems if required | Legalise refers to ensuring the final version is technically compliant |
|  |  <p>AUDIO</p> | N/A                     | PCM  | Audio also conformed at same time as relink       | Create embedded AAF | Audio processing device | Audio exported as .wav file |  |

# PART 4: DELIVERY





## BEFORE YOU START

The final delivery of content from production companies is the start of the broadcaster's own internal processes. UHD will not ever exist as a traditional "tape" delivery format and therefore will be file-based only. The delivery of files over computer networks, especially if you need to use the internet, can be slow at the best of times. You'll definitely need to allow more time to deliver your large UHD files.

## VARIANT DELIVERY FORMATS

Most production companies are required to make TX masters for their UK and International broadcast customers. Within the UK, the new DPP UHD delivery standard will be the primary format for this. However, sometimes you may be required to produce variant delivery formats such as IMF, the Interoperable Mastering Format, either because of the specific nature of the deal and the rights sold, or because you are dealing with overseas commissioners who are acquiring several different masters. Note that 'variant' means different formats: if the material was being edited simply for duration or content, then it would just flow through the post production process again. There's no particular change here from HD, except that whereas there are a small number of widely-used standards for HD deliverables, the world of UHD hasn't reached such standardisation yet. This means you may have to produce more variant formats for UHD. However, the DPP's international partnerships are aiming to reduce this complexity over time.

## TRANSCODING

Although transcoding is regularly used to produce different versions, it's very early days in UHD. When transmitting in HD it is normal to generate a SD version at the same time. Where a broadcaster is transmitting a UHD and a HD version at the same time, a similar conversion needs to be made. There may be some issues regarding 50p programming acquired with a short shutter, since these may judder when converted to 25 frames per second. Similarly there may be issues with trying to make HDR material look good in SDR. For these reason it may be necessary to provide separate HD deliverables.

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## VERSION CHECKS

There's no change here. Just as in HD, some people will wish to check their transcoded assets. While this is possible on a number of players, it's important to use tools that can provide a good quality video display to provide confirmation. It's best practice to carry out a full quality check after a transcode.

## ARCHIVE POSTERITY AND RIGHTS LOGGING

Once again this process doesn't change with UHD. The production company may archive the project and create an archive log – whether for posterity, or to start the process for finalisation of the rights. Your broadcaster is likely to require you to complete cue sheets and Programme as Completed (PasC) forms.

## GENERATION OF MASTER FILE

It goes without saying that UHD does not have a traditional "HDCAM style" tape format and will be file-based only. So the DPP UHD delivery standard, published alongside this guide, will be the primary TX Master for most UK deliveries.

The usual steps will still be required to produce your master file:

- 1 Completion of the programme file – with final audio and video.
- 2 Inclusion of Editorial Metadata. This metadata is still based on the AS-11 DPP standard used for HD, and the same metadata is still required, including titles, synopsis, contact information etc.
- 3 Inclusion of Technical Metadata, which will include additional information about the video – i.e. whether HDR or WCG have been used; the format of HDR; and the frame rate of the file.

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## FILE DELIVERY NETWORK

It's already clear that file-based delivery should represent an opportunity for savings and efficiency. The DPP's technical and metadata standards for HD file-based delivery have made the process even easier: there is now just one agreed file format, structure and set of metadata requirements for the UK's seven major broadcasters. The aim is to do exactly the same for UHD.

Broadcasters have adopted secure, accelerated file delivery over IP networks. Even with this acceleration, large UHD files will still be slow to transfer over slower networks such as the internet. There is no getting away from the need for faster network connections when delivering large files. In the near term, it may even be the case that we see file-based delivery of some UHD Programmes on removable drives. This would require careful discussion however between the production team, post production facility and the broadcaster.

While the use of removable drives for delivery may make commercial and logistical sense for production companies, it is less effective for broadcasters: they would prefer to receive files over an IP network so that they can avoid having to copy files manually, and can make use of fully automated workflows which start right at the entry point into the broadcaster's architecture.

As we saw with HD file delivery, broadcasters will be likely to take the lead – with key suppliers – in defining the most effective and pragmatic means of file delivery for these new larger files. As always, if you're in doubt, then communication with your broadcaster will be key to a happy resolution.

### DPP RECOMMENDS

In the early days of UHD it may be reassuring to do a test delivery to your broadcaster part way through your post production. It could reduce stress at the end of the edit.

# DELIVERY ACTIVITIES

| DELIVER               |   |                                |
|-----------------------|---|--------------------------------|
| TX MASTER             | TRANSCODE FOR NON-BROADCAST DISTRIBUTION                              | ARCHIVE                        |
| AS-11 DPP UHD format  | Transcode into lower bitrate file formats for web, mobile and tablets | Long term file-based archiving |
| Integrated with Video | Integrated with Video   | Integrated with Video          |



VIDEO



AUDIO

# CONCLUSION

Reading the reality of what it takes to make content in Ultra High Definition may make you feel a little weary. Just when you'd got used to High Definition, and then to file-based working, along comes something new again – and something that brings a cluster of other abbreviations like HDR, WCG and HFR trailing in its wake.

So why is UHD worth the trouble? What could make you energised rather than tired at the prospect of working in this new resolution?

The answer in one word is immersion. UHD – particularly when accompanied by other attributes such as HDR – has an immersive quality which is extraordinary. Some people regard it as more effective (and certainly less sick-making!) than 3D when it comes to drawing viewers into a scene. The arrival of UHD – and still higher resolutions to come – may also trigger a new approach to media which really explores the possibility for manipulation of the image: UHD graphics and augmented reality promise to be hugely exciting.

It is almost a rule of working in media that it never gets easier or cheaper. Just as one format or style has been mastered, along comes another – to make us feel as we have to learn our trade all over again. But in reality of course we don't start all over again. We build on our experience to find ourselves creating films and experiences we couldn't have imagined a decade before. And that, of course, is what we find compelling about our industry.

So it's worth immersing yourself in UHD – so that you can immerse others. They'll thank you for it.

# GLOSSARY

**4K** A picture format with around 4000 pixels on each line. Originally referring to digital cinema at 4096 pixels wide, but now often used incorrectly to refer to UHD TV at 3840 pixels wide.

**8K** A picture format with around 8000 pixels on each line. Sometimes referred to as UHD-2.

**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.

**BT.2020** See *ITU-R BT.2020*.

**Codec** *Coder/Decoder*. A method used for encoding (and usually compressing) video.

**Cloud** The term Cloud usually refers to Cloud Computing where on-demand computing resources such as networks, storage, applications and services are provided to users by remote servers.

**Colour Gamut** The range of colours able to be displayed by a particular format.

**Colour Management** refers to the understanding and subsequent controlled conversion of colour to ensure that colours appear correct on different displays and devices.

**Conforming** Re-link the edit sequence to the high resolution master media after a low resolution edit.

**Data Rates** The amount of data used per second of video/audio (e.g. 5Mbps = 5 megabits of data per second of video).

**DNxHD** Avid's preferred HD codec.

**DNxHR** Avid's preferred UHD codec.

**DPX** *Digital Moving-Picture Exchange*. A 'digital intermediate' video format most often used for visual effects and grading.

**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.

**HLG** *Hybrid Log Gamma*, a royalty free form of high dynamic range compatible with standard dynamic range displays. Approved by the ARIB Standard B67, by the Association of Radio Industries and Businesses.

**25p**: The "film look" that most dramas and natural history programming use now.

**50p**: 50 full frames per second (instead of traditional TVs 50 fields per second), which reduces motion blur on fast moving images such as sport. 50p is expected to be the starting point, and over time, higher frame rates, which exceed 100 frames per second, may be possible.

**IMF** *Interoperable Mastering Format*. A file format used for mastering and exchange of content, especially in the US and often by the movie industry.



**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. Please note that UHD does not have an interlaced variant. The closest equivalent to interlace in UHD-speak is 50p.

**IP** *Internet Protocol*, which defines a method of communication between devices on an IT network. Each device is assigned an IP address, a numerical label that allows each device to identify each other and know where to send information in order to communicate/send files.

**ITU** The international standards body (part of the United Nations) that sets the world’s television standards and manages the allocation of broadcast frequencies.

**ITU-R BT.2020** (often shortened to BT.2020 or Rec 2020). A standard developed by the ITU, allowing a greater range of colours to be displayed to viewers.

**Logarithmic** A Logarithmic scale is a nonlinear scale which is used to represent a large number of quantities in a single graph typically by showing a curve rather than a much larger straight line. It is based on orders of

magnitude and in video is used to represent the dynamic range captured by a particular camera. Sound loudness and light intensity are also based on logarithmic scales.

**LTO** *Linear Tape-Open* – a type of digital datatape often used for archive and back up of file-based media.

**LUT** A LUT, or *Lookup Table*, also sometimes called a 3D lookup table (3D LUT) is used to convert images with different dynamic ranges and colour spaces to ensure they look correct on different displays, such as when viewing a high dynamic range signal on a standard HD monitor.

**MAM** *Media Asset Management* (system). A database that allows searching and browsing of video and audio content.

**Master/Mastering** The creation of a TX Master (the final production output version ready for transmission). See the DPP’s UHD delivery standard on our website:

<http://www.digitalproductionpartnership.co.uk/>

**Mezzanine Format** This refers to a high quality conformed version of the programme which can then be used as a source for different master versions – SD,HD, UHD etc. It is sometimes also referred to as a digital intermediate.

**Metadata** Technical and contextual information about the audio and video content that is recorded and edited. In the tape world this would have included information written on the tape or notes included on the tape cartridge. In the file-based world it relates to information labelled against the card or file.

*Physical Metadata:* card labelling.

*Technical metadata:* the facts stored in the file wrapper, e.g. the codec, bitrate and file size.

*Descriptive Metadata:* logged information that describes the content of the video/audio.

**Native Editing** Editing media in the original ‘native format’ in which it was created (without prior transcoding or transwrapping).

**Native Format** The original format to which the camera encodes (also referred to as source format).

**NLE** *Non-linear Edit [suite]*; such as Avid Media Composer, Apple Final Cut Pro, Adobe Premiere, Autodesk Smoke, Quantel Pablo and Sony Vegas.

**Object based audio** A method of recording audio which treats each source of sound as its own “object”. These objects are then mixed by the receiver into as many channels as makes sense for that device (perhaps one for your phone, but 20 for a cinema).

**PCM** *Pulse-Code Modulation*. The method used for converting uncompressed audio into a digital signal.

**Pixels** *Picture Elements*. The individual dots that make up an image.

**ProRes** Apple Final Cut Pro’s preferred codec.

**Proxy** A lower resolution or lower bitrate copy of the master media used for review or editing. Proxies are sometimes generated in camera, on ingest or at the start of editing for the ease of handling the media.

**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 simply four times the resolution of HD.

**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** See *ITU-R BT.2020*.

**Resolution** The number of pixels used to make up an image.

*Progressive*: A scanning mode that describes the way the picture refreshes. The whole image refreshes at the same time. At low frame rates such as 25 fps this gives a filmic quality to the recorded pictures. UHD only exists as a progressive format but can work at higher frame rates to improve motion blur.

*Interlaced*: A scanning mode in which the odd lines of pixels are scanned first followed by the even lines of pixels a fraction of a second later. This creates two fields of pixels giving a perceived doubling of the picture refresh rate, but where each field has half the resolution of the whole frame. For example, at 25 frames per second, the picture is divided into 50 interlaced fields per second giving a more realistic “video” look than progressive scanning.

**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.

**SMPTE-2084** sometimes known as Dolby PQ is one of the possible standards for high dynamic range.

**Transcoding** The process of translating video from one format to another.

**TX** Abbreviation for *Transmission*.

**UHD-1** Is a video format with a resolution of 3840 pixels wide by 2160 lines, which is 4x as many as HD.

**UHD-2** Is a video format with a resolution of 7680 pixels wide by 4320 lines which is 16x as many as HD.

**WCG** *Wide Colour Gamut*. See Colour Gamut.

**Wrapper** Also referred to as a ‘file container’. This is the file structure around the video/audio codec that contains technical metadata about the video/audio.

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This DPP production was brought to you by Rowan de Pomerai and Andy King, with lots of help from Lisa Kelso, and a little from Mark Harrison. Vlad Cohen's design has once again made our words more pleasant to read.

The authors would very much like to thank the many DPP Members who have contributed to and reviewed this guide: their input has been invaluable.

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