



Avid Workflows for Digital Cinema Cameras

2014
Media Composer

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Table of Contents

OVERVIEW	4
PICTURE	4
AUDIO WORKFLOW CONSIDERATIONS	5
ADVANTAGES OF SYNCING AUDIO IN MEDIA COMPOSER	6
WORKING WITH AMA-LINKED MEDIA	8
DAILIES CREATION	8
FRAME RATE CONSIDERATIONS	9
WORKING WITH DAILIES FROM THIRD-PARTY SYSTEMS	10
CREATING MASTER CLIPS FROM AN AAF/ALE	10
EDITING WITH MXF DAILIES	11
CONFORMING WITH THE ORIGINAL CAMERA FILES	11
COLOR MANAGEMENT	12
LUTS	12
ASC CDL	13
BACKGROUND TRANSCODE SERVICES	14
DYNAMIC MEDIA FOLDERS (DMF)	14
2K+ COMPOSITION MANAGEMENT	15
FRAMEFLEX™	15
PREPARING SEQUENCES FOR CONFORM	16
REMOVING EXTERNAL LUTS	17
DIGITAL CINEMA CAMERAS	17
RED DIGITAL CINEMA CAMERAS	18
HD FINISH OF R3D FILES IN AVID MEDIA COMPOSER	19
MXF/DNXHD RELINK	21
AMA CONFORM FROM A REDCINE X PRO OFFLINE TRANSCODE	21
ARRI ALEXA	23
CODEC	23
LOGC LUT	24
ARRI PRORES OFFLINE/ONLINE	25
MEDIA COMPOSER OR MEDIA COMPOSER WITH SYMPHONY OPTION FINISH	26
ARRIRAW	26
BLACKMAGIC CINEMA CAMERAS	27
OFFLINE EDITING WITH BLACKMAGIC	28
WORKING ONLINE WITH BLACKMAGIC	29
SONY F5/F55	29
BENEFITS OF PROXY WORKFLOWS	31
XDCAM PROXY AND 4K XAVC	31
XDCAM PROXY AND SONY RAW	33
2K+ CONFORM	34
USING EDL VS AAF	34
AAF CONFORMING	36
SUMMARY	37
APPENDIX A: COLOR CORRECTION AND DAILIES SYSTEMS	38
APPENDIX B: AAF RESOURCES AND INFORMATION	39
APPENDIX C: RED CAMERA METADATA MAPPING	40
APPENDIX D: ARRI ALEXA METADATA MAPPING	41

Avid Workflows for Digital Cinema Cameras

Overview

Since the introduction of the Sony 24p HD camera to the market in late 1999, the world of digital cinema has evolved dramatically. But while cameras, formats, codecs, and resolutions seem to change almost every month, there are actually only a handful of reasonable options for a postproduction editorial solution. When considering the options, it is important to weigh all technological choices in terms of advantages and disadvantages to the overall goals and delivery of the program itself. Content producers should take a holistic approach to what is right for the entire production. Systems need to be flexible and extendable to meet not only the creative needs of the project, but also the overall deliverables for today's world of multichannel distribution.

Avid Media Composer is the leading solution for both in-the-box finishing of HD projects, as well as for maintaining all metadata and changes when conforming and finishing hi-res projects in third-party systems. This document will detail numerous digital camera workflows using new features in Avid Media Composer 7, such as; Dynamic Media Folders (DMF), color management with ASC-CDL support and LUT support, and region of interest with FrameFlex™. Some general terms and concepts to be familiar with when creating a digital cinema workflow will also be highlighted. Any of the processes described will be common to all workflows cited, and all will have features that need to be understood and considered to form a comprehensive postproduction plan.

This document will concentrate on workflows that are associated with greater than HD size capture (2K+), and finishing at HD or greater resolution. The workflows described will focus on several popular formats used in digital cinema cameras that work with either RAW, QuickTime-wrapped codecs (e.g. Apple ProRes and Avid DNxHD), or compressed Long GOP codecs.

Picture

Delivering HD masters from high-resolution images offers the freedom to make creative or corrective reframing decisions with little to no quality loss. Some examples are; doing a slow push in to emphasize a dramatic moment, reframing to remove a boom mic from the scene, or changing the frame composition from a two shot to a single. Using the FrameFlex™ feature introduced with Media Composer 7, these extracts can be easily performed on the entire source clip or on any span defined in the sequence.

Another option is to record directly to “editorial ready” codecs such as Avid DNxHD or Apple ProRes. Many of today's high-resolution cameras are hybrid cameras in the sense that they can simultaneously record HD proxies in addition to their 2K+ formats. This gives greater flexibility in choosing a camera, as many jobs may not require a 2K+ capture. There are also several recorders that can attach to the HD-SDI or HDMI output of the camera and record HD media either as a higher quality format than the camera's internal codec format, or as a proxy to the camera's hi-res format. One example would be the Sound Devices PIX recorder used in conjunction with a RED Digital Camera. Each of these solutions can change the overall workflow of a production and need to be considered in addition to the primary and secondary deliverables of the program itself.

Avid Workflows for Digital Cinema Cameras

Typically, most productions will already know what their primary delivery format will be before beginning principal photography. Broadcasters provide exact delivery specs for their content providers, and most post houses will offer up best practice guidelines for clients using their facilities. In most cases, the various workflows share a common set of recommendations, but each of the cameras may carry specific steps that are unique for format, codec, or color management. The matrix of input formats and deliverables will dictate the workflow used for any one production.

Content producers have many choices in today's market for digital cinema grade cameras; each with various features, sizes, and budgets to meet the needs of any production. What works as an "A" camera on a small budget film will also work as a "B" camera on productions with bigger budgets. The common attributes are the quality of the images being captured and how they can be manipulated in post to achieve the desired look that fits the story.

Audio Workflow Considerations

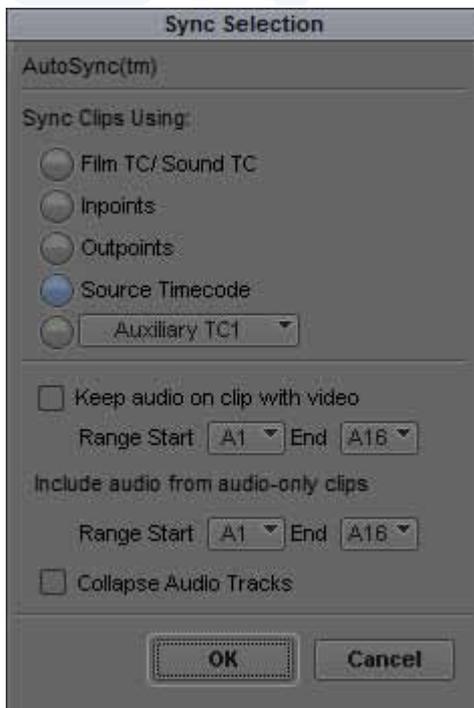
Regardless of camera type, the decision between using a single or double-system audio workflow is based on a variety of factors, including crew size and budget. Single-system workflows can be considered more convenient, with picture and sound already in sync as part of the recording, but this method does come with some drawbacks. One particular challenge is that the camera operator will need to pay attention not only to composition, focus and movement, but audio levels as well. A double-system workflow solves this issue since there is a separate recording device and a person dedicated to monitoring the audio. Double-system recording also offers the advantage of being able to capture more than the 4 audio tracks typically found on digital cameras.

Third party applications are often used as part of the dailies process and can provide the ability to sync picture to double-system sound. While many of these free applications are useful for creating "review" dailies not intended for actual editorial, they don't usually parse or retain enough of the audio metadata, making audio conform rather problematic in post.

Advantages of Syncing Audio in Media Composer

A great solution for syncing picture to double-system sound is to perform this operation within Media Composer. Media Composer will not only properly parse and retain the audio metadata, but will also provide a "one-step" sync with the mix track from the sound files, rather than all the other ISO tracks. This makes for a simpler and more fluid editing process. Because of Avid's robust clip relationship architecture, the editor can easily match frame back to the original BWF file should they want to edit with one of the ISO tracks, rather than just the mix track.

Avid Workflows for Digital Cinema Cameras



With this method, the editor is never more than two clicks away from the ISO tracks. This functionality can be found in the AutoSync™ tool. The options in AutoSync also allow for one-step syncing while managing an audio “scratch track” from the video clips in addition to a selection of ISO and Mix tracks from the original multi-track WAV files. Media Composer 7 does offer a WAV/iXML AMA Plug-in for parsing metadata from the WAV files. Please refer to the Media Composer documentation for specific functionality when compared to import as they are not the same.

Another advantage of syncing within Media Composer is the ability to easily slip sync when the camera and sound recording devices do not have the exact same timecode. Cameras and sound recorders can drift over the course of a shooting day, especially if not properly jammed-synced together on a frequent basis. Media Composer can slip the sync between an audio and video clip in quarter-frame accuracy, as well as track this sync offset to ensure that any conforming done later can recreate the perfect sync. This value can

be found in the PerfSlip column and will have a “-” (negative or minus) for slipping audio earlier than picture. For example, in a 35mm project, a PerfSlip value of 6 would be the equivalent of 1.5 frames or 3003 samples at 23.976 and would represent audio being delayed in respect of picture as it has no “-” in the value.

Since the ability to perform slip sync is only available while in a film project, digital video productions working at 23.976fps, 24fps, and 25fps may choose to create a film project despite the fact there is no film being used. The granularity of the slip is based on the film gauge selected:

- 35mm 4 perf allows for 1/4 frame resync
- 35mm, 3 perf allows for 1/3 frame resync
- 16mm allows for 1 frame resync

Selecting 35mm will give you the most control over sync, whereas 16mm is 1 perf per frame and as a result is frame-based, offering no advantage at all over a video non-film based project as far as syncing is concerned.

Although choosing a “Film” project in Media Composer offers additional functionality for any kind of production workflow, you need to be aware of one small limitation. When editing from subclips created in a film project, one cannot go past the boundaries of the subclip itself in the timeline; a behavior similar to reaching the edge of a masterclip. This was designed to protect metadata that can be different at the head of each subclip. Such metadata includes; KeyCode™, Ink Numbers, and all timecodes except for “Start.” Other than this change, you will not notice any differences when using a film project.

Avid Workflows for Digital Cinema Cameras

Syncing via the timeline first to create synced subclips no longer works with any of the source settings active. This is because they are considered effects. If the clip on the timeline has a green dot on it, use clip-based syncing directly in the bin.

Working with AMA-linked Media

Introduced with Avid Media Composer and Avid Symphony v3.5, the Avid Media Access (AMA) plug-in architecture allows for direct and instant access to a wide variety of camera codecs available today. The ability to sort, log, and edit instantly has distinct advantages for many program workflows, especially those with quick turnaround demands. Understanding the advantages and disadvantages of AMA depends on several factors and there is no hard and fast rule for whether you can successfully edit under AMA linking for the entire process or whether you will need to transcode. Such factors to consider are: the footage to storage ratio, expected system performance (e.g., lots of layers, multicam, etc.), working on a SAN, and the comfort level of self-managing all aspects of your media versus using Avid's MediaFile management system. For digital cinema workflows in particular, transcoding is recommended. In Media Composer 7, the introduction of background transcoding has greatly improved the efficiency of file-based workflows when transcoded media is desired.

Dailies Creation

There are many "dailies" software solutions for file-based formats. Solutions range from the free DaVinci Resolve Lite software to paid applications such as ColorFront, Baselight, Flexity, YoYo, Pomfort, Convey, etc. (See Appendix A for a full list.)

When transcoding in third-party applications, be aware of the black and white levels of the resulting file to ensure they meet Rec. 709 video standards. In 8-bit terms, video black is 16 | 16 | 16 RGB and video white is 235 | 235 | 235 RGB. When exporting directly out of REDCINE X PRO to Avid MXF wrapped DNxHD, there is a setting for scaling to legal video levels. Many applications work full swing across the entire RGB level set (0-255 in 8-bit terms), this setting will scale 0-255 to 16-235 to look correct on a calibrated Rec. 709 monitor. This is only done as part of the export when the look is baked into the Avid DNxHD media. With the new source LUT support in Media Composer 7, and using AMA to link directly to these files, a full range to Rec. 709 LUT can be applied to create proper video levels for HD.

Avid Workflows for Digital Cinema Cameras

Frame Rate Considerations

Some projects (such as 720p) allow for more real time streams due to the reduced raster size or debayer speed of the format being used. For the sake of metadata accuracy, keep in mind that a 720p.23.976 project counts timecode as 30fps with a 2:3 pulldown per SMPTE specs. AMA-linking to an R3D file recorded at 23.976 will track as 23.976 without consideration of the pulldown. When mixing formats in such a project, an EDL generated from the project will not be accurate as there is no flagging as to what the original frame was, resulting in the source duration and record duration not being equal. An example is this sample EDL where the first event was a 23.976 capture from a 720p/59.94 with 2:3 pulldown removed. The second event is a 23.976 R3D file.

```
TITLE: UNTITLED SEQUENCE.01
FCM: NON-DROP FRAME
001 001    V    C    01:00:39:00 01:00:40:28 01:00:00:00 01:00:01:29
002 253    V    C    23:38:52:23 23:38:55:13 01:00:01:29 01:00:04:16
```

It is easy to see where event #1 is tracking the pulldown frames and that the EDL is a “30fps” EDL since timecodes ending with :28 and :29 are visible in the first event. The second event is not as obvious as being native 23.976, since those timecodes are valid in both 23.976fps and 29.97fps (and 25fps) formats. However, if this EDL were to be loaded into a third-party system, it would either complain or make changes. An example of this would be to insert black on the second event where in a 24fps count the duration is 02:20 and in a 30fps count it is 02:17. If all the footage is 23.976 and the production is using 720p to increase performance with debayering, it is recommended that all EDLs be made in a 1080p/23.976 project by changing the format in the project window beforehand.

The term offline really refers to working in a resolution that is not the resolution of the final mastering and delivery. This is done via lower data rate proxies. In Media Composer, Avid DNxHD 36 is the primary offline codec and delivers high quality images at relatively low data rates. This is valuable when:

- You've got a large amount of dailies being produced
- You're looking for maximum performance for multiple-layer VFX without rendering,
- You're using multi-cam
- You're using local, low-bandwidth (eg. USB, FireWire) drives (a single 1TB drive will hold 65+ hours of Avid DNxHD 36 video)

Despite the benefits to working with offline media, many productions may benefit from working at the target resolution throughout editorial, skipping the additional conform and transcode step altogether. Now with LUT support available directly on source clips in Media Composer 7, “corrected” dailies can be relinked at a finishing resolution (eg. DNxHD 175x). This provides the ability to remove the LUT, allowing the colorist access to the full dynamic range of the camera originals.

Avid Workflows for Digital Cinema Cameras

Working with Dailies from Third-Party Systems

For third-party applications that use Avid's AMT (Avid Media Toolkit) to create native MXF/DNxHD media, there is a fairly common set of steps to follow among them. Generation of an ALE file is not a core component of AMT, therefore one may or may not be created by the application. In some cases, the creation of the ALE is automatic and part of the process, and in others it is a separate step.

Creating Master Clips from an AAF/ALE

1. Copy the contents of the MXF folder into the Avid MediaFiles/MXF folder structure. This folder exists at the root level of the media drives being used and will have the following path: Avid MediaFiles/MXF/1, where "1" is one of many folders containing the MXF files. Media Composer automatically manages the number of files allowed by the operating system to ensure the files are available to you when needed. Once the file limit is reached, another sequentially numbered media folder is automatically created. You can create your own numbered folders to make managing dailies a little easier. One method would be to create a series of folders labeled 101, 102, etc., as a way to track dailies for project 1/day 1, project 1/day 2, and so on.
2. Import the AAF files. Launch Media Composer and open your project. Create a new bin or open an existing one that will contain the new clips. The easiest way to associate the media in the Avid MediaFiles folders is to import all the related AAF files from the AAF folder. This can be done via File->Import or dragging and dropping the AAF files directly into the bin. There are several advantages to importing the AAF file:
 - Quickly associates files to project and bin for organization;
 - Links immediately to MXF files with no further relink step needed;
 - Supports both video and audio, where ALE relink does not.

Another popular method is to import the "msmMMOB.mdb" file directly from the Avid MediaFiles folders to create the master clips. Disadvantages of this method are that if there are multiple projects with media from other days, master clips for them will also be created. The AAF import only references the files from that batch.

3. Merge the ALE into the existing master clips created by the AAF import. Selecting "merge based on known sources" in the Import/Shot Log Setting pane inserts all the metadata from the ALE into the existing master clips. If you do not merge, you will get new master clips that are not yet linked to the media. While this may work for video only clips, it will not link to audio if synced within REDCINE X PRO.

Avid Workflows for Digital Cinema Cameras

It is not recommended that just the ALE file be imported with the AAF files, then use “Relink” to the media. While this works in many scenarios, it does not allow linking to audio, and has shown to become unlinked in certain processes during the postproduction process. ALE files are logging and metadata transfer files and, unlike AAF files, do not contain all the relationship information between the master clip and essence media.

Editing with MXF Dailies

Editing can start from this point, syncing to double-system audio, if needed, or further logging and organization can be done. An optional organizational tip is to take all the new source clips and choose “AutoSequence” from the Bin menu. AutoSequence creates a timeline of all the clips based on their time of day (TOD) timecode. Since the master timecode of the new sequence matches the time of day timecode of the source clips, you can see at glance how all the clips align to time of day. Another benefit is that the auto sequences can be left in the dailies bin in case a master clip that was deleted by mistake needs to be recreated.

Conforming with the Original Camera Files

Once editorial is complete using the offline proxy media, you must make decisions about where and how to conform the sequence back to its original camera files. The first choice is whether it will be finished in an HD resolution for television, DVD or web/mobile distribution, or as 2K/4K for a theatrical finish. Finishing applications can be:

- HD Finish: Avid Media Composer
- 2K/4K Finish: Third-party finishing solutions using AAF.

If finishing at 2K+, the HD deliverable can be derived from the high-resolution master, applying the proper color space conversion as needed. If the production wants to protect for a theatrical release, all the metadata will still be available for conform when an HD master will be the primary deliverable.

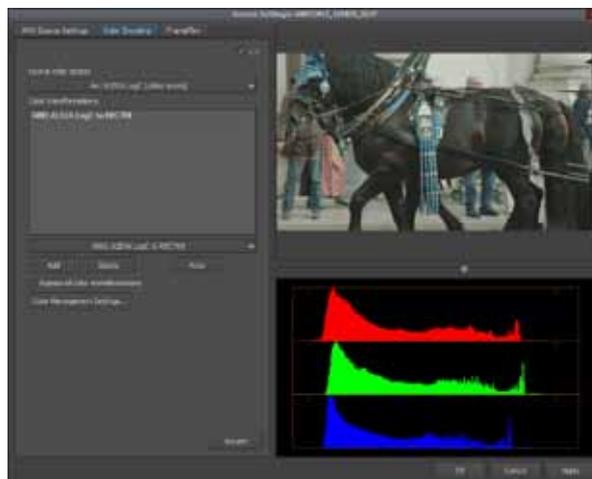
Avid Workflows for Digital Cinema Cameras

Something to note when creating dailies in third-party applications is how the source file is being tracked as metadata in the post workflow. Depending on where and how the files are accessed, the “name” of the file can be different, or tracked differently in Media Composer. This can have an impact on the final conform, whether it is being done with an Avid product or with a third-party mastering system. Some dailies solutions license the Avid Media Toolkit (AMT), which brings a single consistent interface to the MXF wrapper. If they also licensed the Avid DNxHD codec, they can create native MXF-wrapped DNxHD media directly from their system.

Other systems may only use the freely-available Avid DNxHD QuickTime codecs and create the same essence with a QuickTime wrapper rather than MXF. Both can work, but will have some impact on different parts of the workflow and the amount of source essence metadata being managed. Also note that native MXF-wrapped DNxHD media cannot be imported directly into a bin.

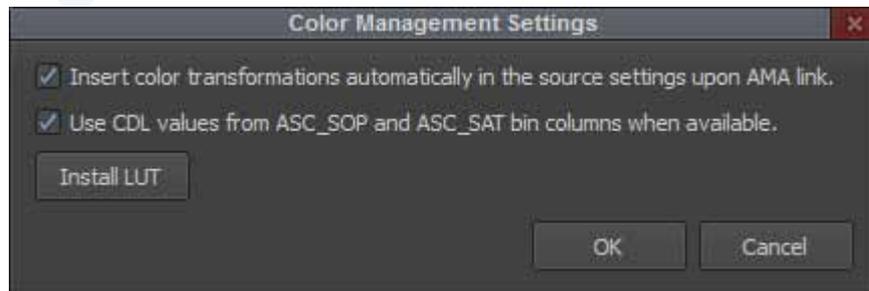
Color Management

LUTs



In versions previous to Media Composer 7, any source media requiring a LUT required that the dailies be done in a third-party application with the LUT “baked” into the image. One of the many new features in Media Composer 7 is the ability to apply a 1D or 3D LUT to any source clip, regardless of whether the media is native to Media Composer or linked via AMA. For many productions this will streamline the dailies process or allow late arriving material to match dailies created elsewhere. Media Composer already includes commonly used LUTs such as LOG to LIN, but you can also import LUTs via the Color Management settings dialog.

Avid Workflows for Digital Cinema Cameras



Supported LUT formats will be:

Avid DS	.lut	AVID DS LUT
Autodesk		LUT: followed by the number of channels and entries
IRIDAS 1D	.itx	LUT_1D_SIZE
IRIDAS 3D	.cube	LUT_3D_SIZE
Kodak KDM	.3dl	# IDENTIFICATION: 3DMODEL-3DLUT
LUTher	.txt	#channels: c3
Mistika 3D	.itx	LUT_3D_SIZE
Nucoda	.lut	NUCODA_3D_CUBE 2

Imported LUTs are stored in the project folder. Removing LUTs from a project is done by deleting them from this folder. There is currently no UI to differentiate LUTs intended for all projects versus LUTs that are project specific, so importing a LUT will be only for the project in which it was imported. A workaround for this is to manually copy the contents of the LUTs folder (found in the project folder) to:

- OS X: Library/Application Support/Avid/ColorManagement/LUTs folder
- Windows: /ProgramData/Avid/ColorManagement/LUTs folder

You will need to copy the LUT as well as the XML file of the same name.

From this point forward, your LUTs will show up in any new or existing project.

Avid Workflows for Digital Cinema Cameras

LUTs can be added to a source clip or multiple clips at the same time. You can define the source color space and then apply a LUT, or multiple LUTs, as needed. Clicking and dragging the LUTs position in the window changes the actual processing order of the LUTs. Process order is from top to bottom. Note that LUTs only apply to source material. There is no support for monitor or export LUTs at this time.

ASC CDL

Another color management enhancement in Media Composer 7 is support for ASC CDL values as live playback metadata rather than just a metadata representation of what was baked into the media at time of dailies creation. In previous versions, ASC CDL values were used to streamline the offline to online process, but with Media Composer 7, the values become much more useful directly at the clip level and played back in real time as metadata.

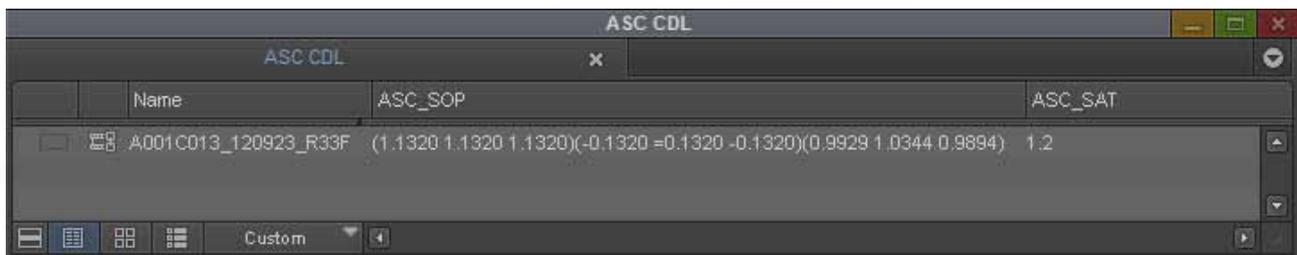
Please refer to Avid whitepaper; “ASC CDL and Avid Workflow” (http://fp.avid.com/resources/whitepapers/avidasc_wp_sec.pdf) for more information on existing functionality. An article on ASC CDLs also appeared in the October 2008 issue of American Cinematographer, available here: http://www.theasc.com/ac_magazine/October2008/PostFocus/page1.php

Dailies can now deliver the original “Log” image in either a native codec or as DNxHD and still have the ability to change color decisions via a LUT, ASC CDL, or both with a simple update of the metadata. This opens up new workflow solutions for projects that require a quick turnaround as well as creative opportunities in working with a colorist throughout the editorial process.

The ASC CDL was defined as a common interchange for simple primary color decisions for Slope (gain), Offset (lift), Power (gamma), and Saturation between different systems. These ten different values appear in the Media Composer bin as ASC_SOP and ASC_SAT columns and will appear as:

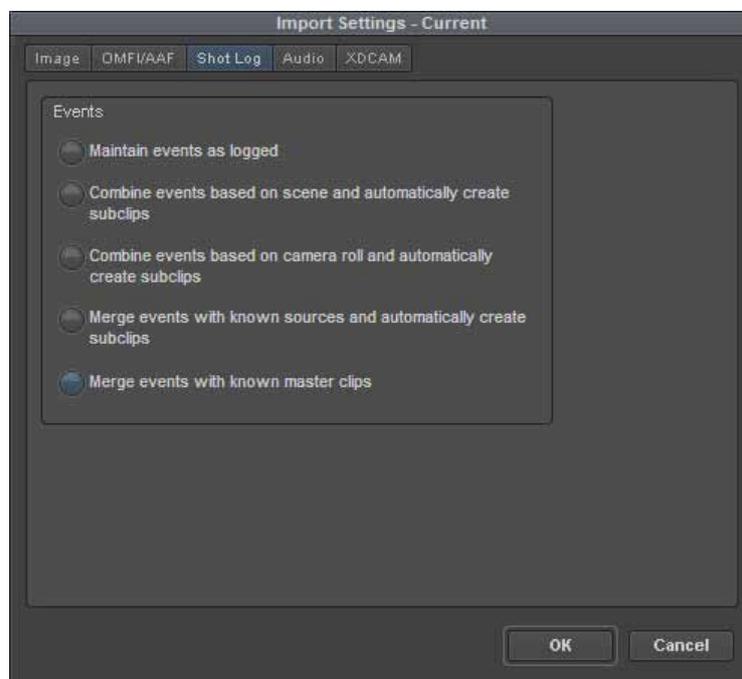
```
ASC_SOP: (1.1320 1.1320 1.1320)(-0.1320 -0.1320 -0.1320)(0.9929 1.0344 0.9894)
```

```
ASC_SAT: 1.0123
```



Avid Workflows for Digital Cinema Cameras

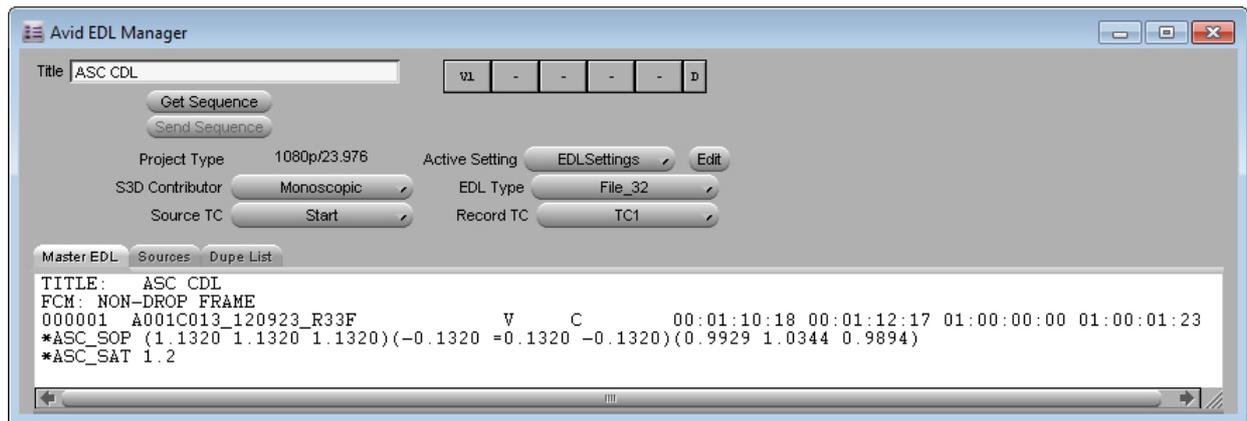
Depending on whether or not the ASC CDL values have already been rendered into your source media as part of the dailies process, real-time playback of the ASC CDL values can be enabled or disabled from within your Avid project's Color Management settings. You need to be careful if ASC CDL values are baked in as part of a third-party dailies workflow. Those values are also being tracked as metadata and, if made active in Media Composer, they will essentially be applied twice (once when they were originally rendered by the third-party application and once again in real-time by Media Composer). The values can be edited and updated directly in the bin or via an ALE merge.



They can also be disabled from within the clip's Source Settings. Media Composer does not track whether these values were part of the essence or not, so a suggestion is to create a custom column for tracking this in case the project ends up mixing these two workflows.

Avid Workflows for Digital Cinema Cameras

In EDLS, ASC CDL values are exported as part of a color correction workflow with third-party systems by adding “Color Information” in the comments section of the EDL.



Background Transcode Services

Dynamic Media Folders (DMF)

Dynamic Media Folders can be a timesaver when dealing with different camera formats. By applying actions to a designated folder on the editing system, your source media can be automatically copied, consolidated and transcoded. The resulting media is created along with new bins or brought into pre-existing bins. Since Dynamic Media Folders can process media files without Media Composer itself being launched, it becomes a more hands-off approach compared to a “transcode in the background” process. Refer to the Media Composer online help for the different controls provided in creating these folders. One note of caution is that camera originals that are not 16:9 native and transcoded to a proxy format such as DNxHD will not work properly with FrameFlex™ when conforming back to the camera originals (see the following section of this document for additional detail.) Also, there is no control at this time to apply a LUT or refer to any of the Source Settings when setting up the actions for DMF. Although LUTs can be applied after the fact if needed, DMF tends to work best when your camera originals are 16:9 and already in Rec. 709 color space.

Some projects, such as those with mostly hi-res source media, may be better served by using Media Composer's Background Transcode service after LUTs and FrameFlex™ operations are applied to the AMA linked media. Transcoding can then be done in the background while you move on to other tasks.

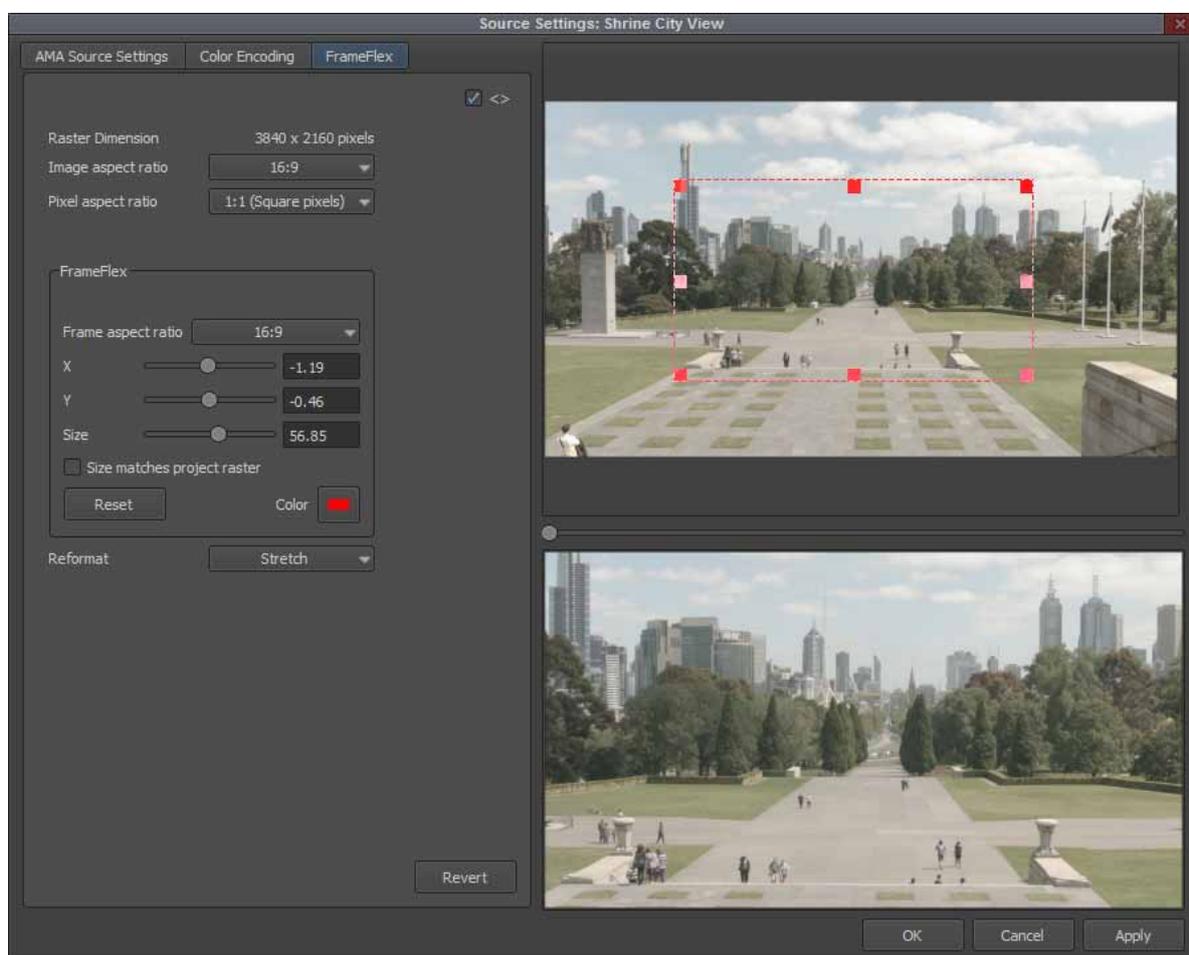
For double system or multicam workflows, it is best to wait until the transcode process is done before doing any syncing or logging as that information will not propagate to the .new, .sync, and .grp clips already created.

Avid Workflows for Digital Cinema Cameras

2K+ Composition Management

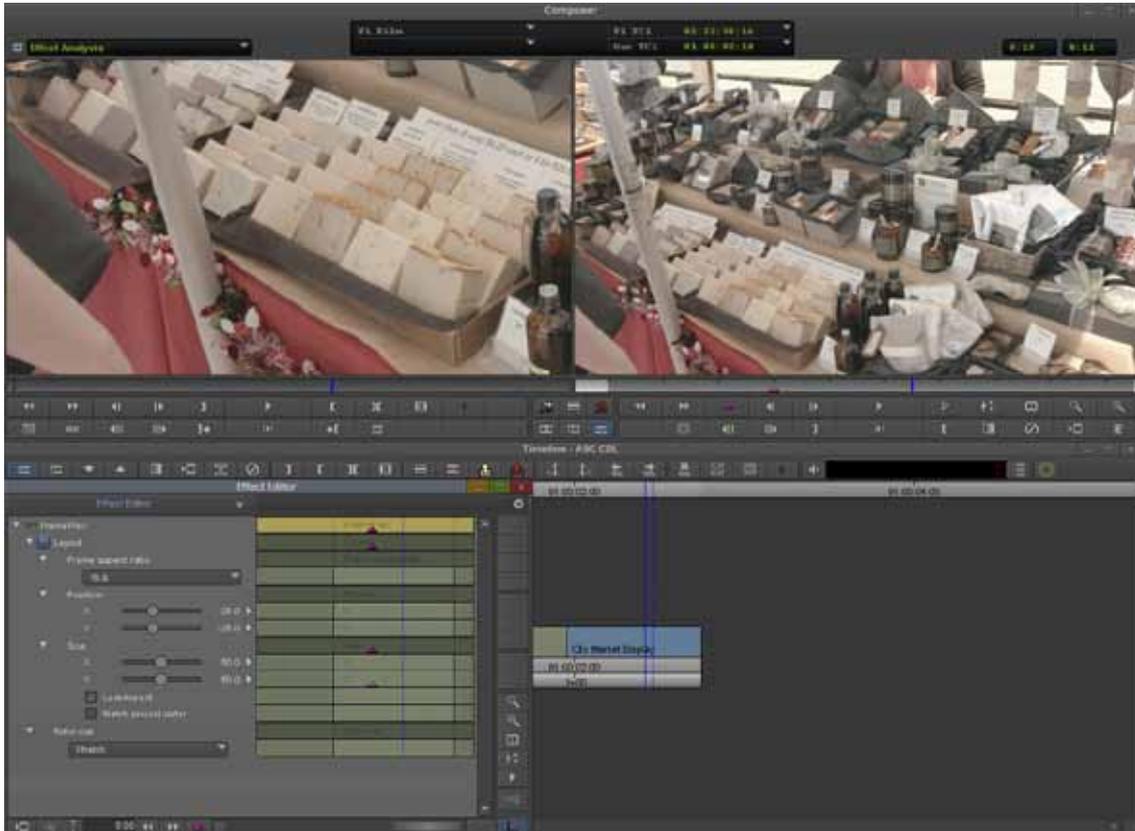
FrameFlex™

Avid's FrameFlex™ feature allows greater than 1920x1080 resolution source clips to be reframed as HD without losing any resolution from the original hi-res media. The default state of an AMA-linked file to a 2K+ file is to scale, and either letterbox or pillarbox, the shot depending on aspect ratio. From there, you can select a new region of interest using FrameFlex™. These parameters can be set on the source clip if a re-frame is needed for the entire clip.



It behaves like a source side effect and will always be applied during editorial. The region of interest is captured as metadata that is now associated with the clip and can be changed at any time in the process. If you only want to affect a specific span of the clip, or to animate the reframed image, this can be done in the timeline by parking on the clip and clicking the Effects Mode button.

Avid Workflows for Digital Cinema Cameras



This will show the FrameFlex™ parameters and any changes that may have already been applied. Changes applied here will only affect that span of the clip in the timeline and not the source clip itself.

Clips that have been reformatted will be noted by a green dot in the timeline. Be aware that the green dot can now indicate any of the following:

1. Frame rate of source clip is different than project (motion adapter applied)
2. FrameFlex™ applied to a greater than HD source clip
3. A color transformation has been applied

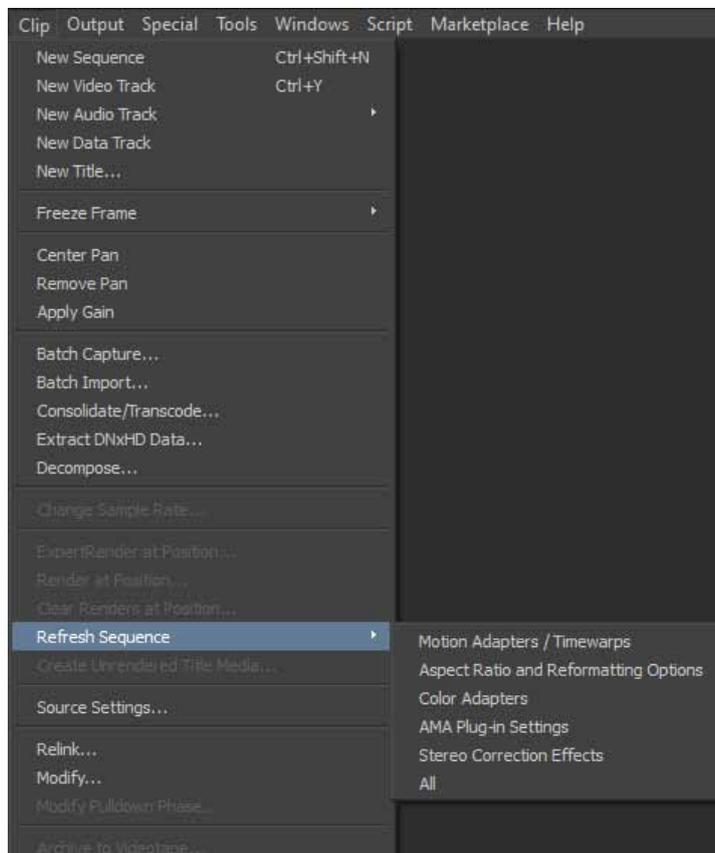
Instead of using Avid's Pan & Zoom effect, FrameFlex™ can also be used on still images. To date, the only sequential frame based AMA plug-in is for ArriRAW (.ari) files and available from GlueTools.

Avid Workflows for Digital Cinema Cameras

FrameFlex™ is in its first phase of implementation, therefore be aware of the following when using FrameFlex™ in a workflow:

- FrameFlex™ is the only method that takes advantage of the higher resolution available in 2k+ source media. All other scaling effects, such as resize and picture in picture, will only use the scaled output of the FrameFlex™ effect (project resolution).
- FrameFlex™ will not appear on Group Clips (.grp). You will need to choose “commit multicam edits” in order to update any shots that have been re-framed.
- Offline and online conform of clips using FrameFlex™ will only work with clips directly accessed by Media Composer to start with. As of this writing, clips created in third party dailies system will not carry the “virtual” frame size metadata needed for the conform to be correctly applied.
 - Media that is not 16:9 and using DMF will not work with FrameFlex™ when using the proxies. The FrameFlex™ conform does not take into consideration the letterbox area of the frame between proxies and camera masters.
- FrameFlex™ does not offer a rotate (Z) at this time

Preparing Sequences for Conform



Changes to a master clip are not always automatically propagated to sequences where it is being used. Color, format, and aspect ratio changes can be made to source clips (in the bin) but the sequence maintains the metadata at the time of the edit. This is to protect sequences that have been signed off and are ready to be output when working in a multi-editor environment. Managing the version process for multiple distribution channels can be challenging, so once a sequence is created, a manual update has to be done on that sequence for it to update to any changes done on the source material.

Avid Workflows for Digital Cinema Cameras

The “refresh sequence” command can be found in the “Clip” menu. While the sequence is active in the record monitor, the following source updates are available:

- Motion Adapters/Timewarps
- Aspect Ratio and Reformatting Options
- Color Adapters
- Source Settings
- Stereo Correction Effects
- All

“All” will update the settings if any of them were changed. Something to be aware of is the difference between Source Settings and Color Adapters in the menu list. Although the Source Settings contains RED RMD, LUT color management, and FrameFlex™, selecting Source Settings only changes the RMD settings. For example, to update only the LUT you would select “Color Adapter”.

Removing External LUTs

At the finishing stage, it is very common for a color correction to start with the camera originals without any LUT applied, giving the colorist full control of the dynamic range of the image. The steps for removing LUTs from the offline sequence are:

1. Put the sequence in its own bin (for ease of source clip identification)
2. Click the bottom left bin menu and select “Set Bin Display”
3. Turn on “Show reference clips”
4. Clicking OK will now show the sequence, as well as all master clips and subclips used in the sequence.
5. Select all Master clips (sort by icon)
6. Right-click on any of the clips and select “Source Settings”
7. Go to the color transform tab and remove all associated LUT or CDL information that may have been applied.
8. Click OK, return to “Set Bin Display” and de-select “show reference clips”
9. Clicking OK will return to a single sequence in that bin.
 - If this needs to be done to several sequences, they can all be done at the same time in the same bin.
10. Perform a sequence refresh to update the sequence.

Avid Workflows for Digital Cinema Cameras

Digital Cinema Cameras

Digital Cinema cameras differ in resolution, size, weight, lens support, etc. Regardless of camera design, the codec type is the one factor that impacts workflow the most depending on the model. These cameras can record in different codecs and will either be clip-based (entire shot is in a single “movie” clip), or will record sequential frames where each shot is contained within a folder. The media may be recorded uncompressed, RAW, or a variety of compressed formats. The matrix of codecs and formats can be quite challenging to keep up with, so understanding the format(s) being used for a particular production is very important to the overall success of the post production pipeline.

Several cameras use a large sensor with RAW-based recording solutions to meet the needs of productions looking to approximate the 35mm film standard. As better decoding and color science is developed, it can be applied to all images recorded to date, allowing for image improvement over time. RAW camera formats are available from RED, ARRI, Blackmagic, Sony, and Canon, as well as via third party recording devices. RAW can be recorded as clip-based and compressed, such as with RED (up to 5K currently), or as uncompressed frame-based, as with ARRI ALEXA (up to 2K currently). Compressed high-resolution codecs are available from Red, Sony, ARRI, and Panasonic, among others.

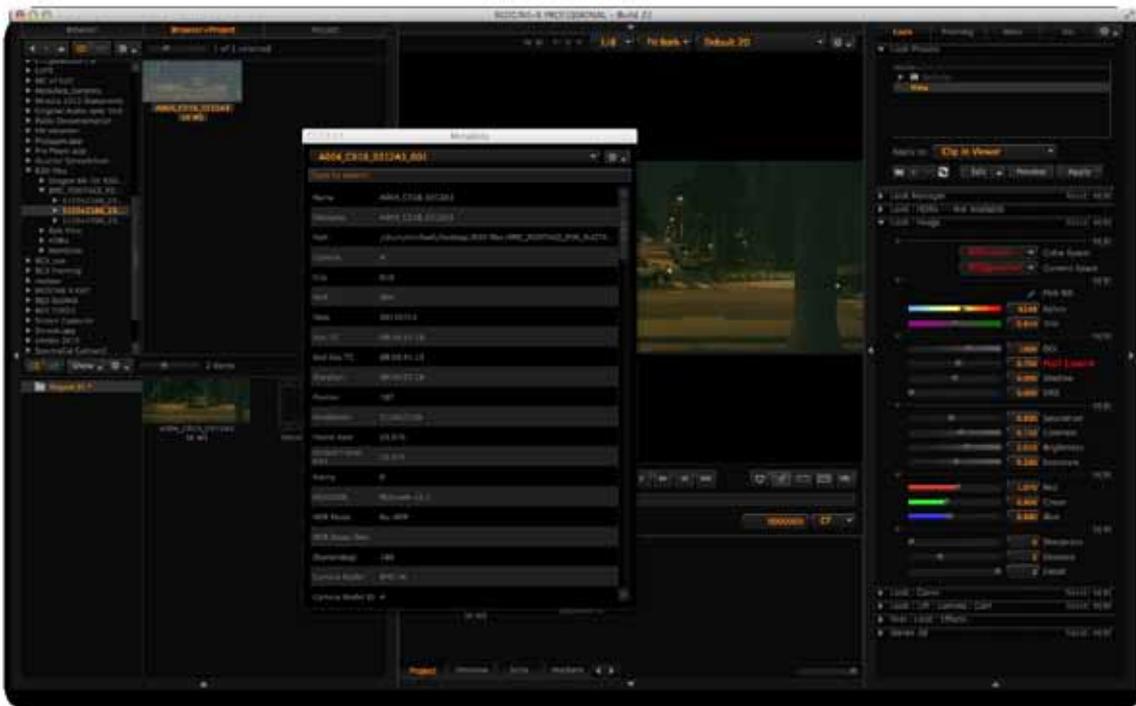
Several manufacturers offer software applications for viewing and or manipulating the metadata within the files as part of the workflow solution (eg. REDCINE X PRO and SonyRAW Viewer software).

The use of RAW formats in a Media Composer workflow comes down to either working with the format directly via AMA, when supported, or transcoding beforehand via a “dailies software” application. There are no AMA plug-ins at this time that support frame-based formats directly. These formats need to be processed in a dailies application beforehand, or via the manufacturers software if available. All supported AMA plug-ins can be found at www.avid.com/ama

Avid Workflows for Digital Cinema Cameras

RED Digital Cinema Cameras

Workflows with RED cameras primarily focus on the R3D file format being recorded, and the use of RED's free image software REDCINE X PRO.



Workflows discussed here will be appropriate for all of RED's camera offerings as all of them create the R3D file format. The differences between cameras are based on model and recording medium, such as resolution and frame rates and support for HDRx in the newer cameras.

One advantage of using REDCINE X PRO is that feature enhancements will be available in REDCINE X PRO before other third parties implement and release them via the SDK. REDCINE X PRO can also be used in a hybrid manner where the overall image look is set first, then applied in Media Composer via the RMD file, which carries the color metadata. This works well when all the parameters of the color controls are needed, since AMA exposes only a subset of the total parameters, but applies all the settings from the RMD file. The one feature and parameter setting not supported at all is HDRx using the two exposed essence streams; only the A channel will be used. If working in an offline/online scenario where lower resolution proxies are being created, the online files can be created in REDCINE X PRO and exported as native DNxHD with all the controls needed. Be aware of the black and white levels of the resulting file to ensure they meet Rec. 709 video standards. In 8-bit terms, video black is 16|16|16 RGB and video white is 235|235|235 RGB. When exporting directly out of REDCINE X PRO to Avid MXF-wrapped DNxHD, there is a setting for scaling to legal video levels. Since REDCINE X PRO is working full swing across the entire RGB level set (0-255 in 8-bit

Avid Workflows for Digital Cinema Cameras

terms), this setting will scale 0-255 to 16-235 to look correct on a calibrated Rec. 709 monitor. This is only done as part of the export when the look is baked into the Avid DNxHD media. The R3D AMA plug-in does not have a button to do the same scaling and will play back the full swing levels, resulting in a different look than if transcoded with those settings. The AMA plug-in interface does offer histograms with legal video level indicators, but these would need to be adjusted on a per clip basis.

HD Finish of R3D files in Avid Media Composer

When finishing at HD with original R3D media and an offline done with proxy media, there are two methods to choose from when conforming:

- Link sequence to all camera originals via AMA
- Transcode all selects in REDCINE X PRO to target mastering resolution and relink in Media Composer.

Depending on the number of original files, both methods may benefit from the pull list to reduce the number of files to just the ones used in the final sequence. Depending on the complexity of the sequence, this can be done in a variety of ways. If the sequence is a simple single layer of straight cuts, then an EDL can be generated directly from EDL Manager. But simple, single layers are rare these days, so the goal is to create a timeline that is just a single layer of clips used in the sequence. The Decompose feature can be used to accomplish this. Decompose breaks the sequence down into all the elements that made it up. To make things easier, strip the sequence of its audio tracks to reduce the number of elements that will end up in the bin. Put the sequence into its own bin, and select “Decompose” from the Clip menu. Media Composer will make sure that all blended transitions have the proper handles applied, but you can enter an additional handle value for all events in order to have frames available for any small changes that may need to be done at the conform stage.

The result of the Decompose process is a set of “.new” master clips. The sort function can help separate the R3D clips from other camera formats when multiple formats were used. Select all R3D-sourced clips and drag them into the record monitor to create a new timeline. This now represents all R3D to be “pulled” regardless how many layers or nests were used for the program itself. Depending on the type of pull list you need, this method will list all spans of the same clip if used several times, and not just a single listing of the file, regardless of the number of times used. Using “set bin display” to show only “master clips” and “show reference clips” will allow the bin to only show the master clips in their entirety once. Select all R3D-related clips and drag them into the timeline to create the “pull” to be used by REDCINE X PRO.

Each method has its own advantages. Using Decompose may offer better storage management, for example, if you have really long takes, and only small portions were used. The benefit of conforming via the pull list method is that regardless of how complex the sequence may be with layers, nests and effects, all that is being changed out is the reference to the MediaFile itself. A perfect conform is guaranteed each time as none of the creative decisions are ever being recreated.

Avid Workflows for Digital Cinema Cameras

Once the “pulled selects” timeline is created, an EDL is generated. Not all EDLs are created equal and a certain type of EDL template must be used for file-based workflow. While the CMX-3600 EDL is popular, it has severe limitations when used with the thousands of files in a modern digital production. The CMX-3600 has the following limitations:

- No more than 8 characters for source
- No more than 254 sources
- No more than 999 events

It is easy to exceed these limitations with today’s cameras and formats, especially where each unique filename can now be considered a source. This is a challenge caused by using “standards” that were created approximately 40 years ago. In order to remove these limitations, new templates were created: File_16 and File_32. The number refers to the number of characters allowed to reference the source filename. The 16-character template works great for R3D files, but other camera formats, VFX elements, and such can easily get up to 32 characters. These templates also remove the source limitation and increase the number of events allowed to 9,999.

This Sequence Pull List EDL can now be imported into REDCINE X PRO or any dailies type application to generate the following options: (for either an AMA relink workflow or native Avid MXF/DNxHD media.)

- Copy the entire original R3D file and associated RMD file with original .RMD and .RDC folder structure to a target drive or directory.
- Copy just the spans used in the EDL (from the Decompose method) as consolidated R3D files to a folder structure drive or directory.
- Transcode to a new Avid DNxHD codec type for finishing, such as Avid DNxHD 175x. Note: The new Avid DNxHD 444 is not yet available in REDCINE X PRO. If finishing at this resolution, then use AMA link to and transcode in Media Composer while in an RGB 709 project type. This only impacts the creation of DNxHD 444 from HDRx clips; these would have to be done as ProRes 444 (if on Mac) or another 422 format.
 - When generating selects from the same original R3D file, the AAF folder will not contain an AAF for each of the elements. For example, if three sections of the long R3D file were used, the MXF folder would contain three MXF files, but the AAF folder will only contain one AAF. This is because the AAF file is not being versioned and is overwriting itself. The remaining AAF file will represent the last span created from that file. If all of the newly created MXF files are in their own numbered folder in the Avid MediaFiles/MXF folder structure, then the msmMMOB.mdb file from that folder can be imported into a bin, and the master clips will be created.

Avid Workflows for Digital Cinema Cameras

If using an EDL of the original sequence, and not a “Pull List” sequence with handles being defined in either Media Composer or REDCINE X PRO, be sure to set the import EDL timecode to be “exclusive” in the Import Settings, meaning that it is +1 frame from the frame actually used in the sequence. Again, EDLs by specification are inclusive for the IN and exclusive for the OUT. If this is set to “inclusive,” the resulting MediaFile will be 1 frame short and will not relink. This is not an issue if handles were added somewhere in the process before the transcode takes place. Depending on the workflow chosen, the result will either be a folder of R3D files or a folder with MXF, AAF and ALE as was generated with the offline workflow. REDCINE X PRO workflow will not support any repositions and “push-ins” that may have been done during editorial. The new FrameFlex™ functionality in Media Composer 7 allows for high quality extraction from a greater than HD frame size. This information would be preserved if using the AMA conform process or AAF in applications that can extract the region of interest and resize information.

MXF/DNxHD Relink

If MXF/DNxHD media was created, the process is very similar to the offline steps already outlined. Copy the MXF files to an Avid MediaFiles/MXF/numbered folder, import the AAFs to a bin, and merge ALE. Once the media is online and accessible, highlight the original offline edit (not the pull list) as well as all the newly created high-resolution clips. With sequence and master clips highlighted, go to the Clip->Relink menu and select “Relink.” Within the Relink settings, check the “relink to selected” option. This will force the sequence to only look at the newly created clips and relink. Because it is difficult at times to tell the difference between DNxHD36 and DNxHD175x, you can easily color the clips referencing the DNxHD175x a single color, so once relinked, use “source color” in the timeline to quickly verify that all the clips were relinked to the high-resolution files. The timeline also offers the ability to display a clip’s codec resolution as text, but that is not as quick as using color to verify a complete conform to the proper media and it is geared more toward a timeline with multiple codecs used and a general relink performed versus the more targeted approach of “relink to selected.”

AMA Conform from a REDCINE X PRO Offline Transcode

The following process will only work in version 6.5 and later of Media Composer and Symphony due to the inability to relink spanned filenames between Tape and Source File. For productions using earlier versions of Media Composer that started with a REDCINE X PRO offline, the only solution is the REDCINE X PRO pull list method and generating new DNxHD media. The same goes for starting off via AMA and using the transcode method for the online process. The relink process uses an exact string match method (with uppercase/lowercase ignored as an option) to make it all work. Third party applications using Avid’s AMT to create native MXF/DNxHD media will always place the source filename in the Tape column. Depending on application, the interpretation of Source File name can be different or left to you to define. In the case of R3D files, AMA sees the entire filename, including extension, whereas REDCINE X PRO using AMT only inserts the base filename. This becomes an issue with clips that pass the 2GB file limit and spanning is done to manage the files; spanning adds a _001, 002 to the filename. AMA will also add the extension as in .r3d.

Avid Workflows for Digital Cinema Cameras

The same original file generated by REDCINE X PRO or linked via AMA will look like the following in Media Composer:

- REDCINE X PRO: R075_C003_12098T and tracked via the Tape column
- AMA: R075_C003_12098T_001.R3D and tracked via the Source File column

Changes in version 6.5 of Media Composer and Symphony address this issue by allowing the relink process to ignore extensions as well as any set of characters after the last “Insert Character or Symbol.” In this example, “Ignore Extension” would be active and an “_” (underscore) would be added to the “Ignore After,” so internally this ends up with both sources looking like R075_C003_12098T and a successful relink can now be done. The relink function includes the ability to relink across different timecode fields as well as columns, allowing full flexibility in conform when dailies are being made by different vendors and metadata is being stored in different fields.

Relink

Relink selected items to:

Media on drive: All Available Drives

Load media database(s)

Relink selected master clips
Tip: To bring master clips online, first try loading media databases.

Relink only to media from the current project

Selected items in ALL open bins

Allow relinking to offline items

Relink by:

Original	Target (if different than Original)
Timecode: Start	Timecode: Start
Source Name: Tape Name or Source File ID	Source Name: Tape Name or Source File ID
<input checked="" type="checkbox"/> Ignore extension	<input checked="" type="checkbox"/> Ignore extension
Ignore characters after last occurrence: <input type="text"/>	Ignore characters after last occurrence: <input type="text"/>

Match case when comparing source names

Video Parameters

Relink to: Video format of current project only (1080p/23.976)

Relink method: Highest Quality

Relink if quality: is greater than or equal to

Format: 1080p/23.976 Resolution: AVC-Intra 50 MXF

If no match is found: Use Existing Media

Tracks to relink

Video Audio Data

Create new sequences (0 sequences selected)

OK Cancel

Avid Workflows for Digital Cinema Cameras

In many cases, it will be faster and more convenient to relink to the original R3D clips via AMA. This could be from the R3D selects via the Pull List method or directly to drives as originally archived. In either case, the process is the same; it is more about the number of files being linked to and management of the R3D files. The Pull List method reduces the number of files to just those being used and, depending on shooting ratio, will streamline the file-management process. Also, in the case of R3D files, until there is an update to include the DNxHD 444 codec, the only way to go from R3D to DNxHD 444 is via an AMA link and transcode within Media Composer in an RGB 709 project type.

This method will also use the Relink to Selected method already described, but all R3D files will first need to be linked via AMA. Depending on file management procedures, you may end up with one bin of all selects, or multiple bins to represent the original camera files. It does not really matter to the relink process, but is more of how you wish to organize the conform process. Again, using clip color on all the AMA clips to quickly confirm the relink process was successful is recommended. The relink process is exactly the same as outlined in the previous method. Select all high-resolution clips in all bins as needed as well as the original offline sequence. Select relink to selected, ignore extensions, and “_” and the relink will be performed. It is also suggested that the “match case” option be turned off for relinking with R3D files, depending on whether the ALE File was merged or not during the offline process from a REDCINE X PRO transcode. If not, the filenames are all lowercase, whereas the ALE merge makes them all uppercase to match the original filename and thus AMA will reference them the same way. So in addition to the different columns to manage the filenames, they may also look like:

- REDCINE X PRO without ALE merge: r075_c003_12098t
- AMA: R075_C003_12098T_001.R3D

Note that when linking the sequence to the original camera files, they no longer carry any of the user-generated metadata that may have been applied during the editorial process. Items such as clip name, comments, and descriptions will no longer be available via the sequence. One might consider an ALE export from the offline clips and merge into the new to carry all relevant original metadata gathered during the post process into the new AMA linked files. The success of this process will depend on whether the new files match exactly in START and END. A consolidate process, for example, would prevent this from happening.

Once the sequence has been conformed, additional finishing tasks such as titles and sound mix can be completed and output directly from Media Composer or Symphony to meet the final distribution requirements.

Avid Workflows for Digital Cinema Cameras

ARRI ALEXA

Codec

The ARRI ALEXA offers two workflows for digital cinematographers, depending on the needs of the production. The camera can record Apple ProRes and Avid DNxHD formats directly to the camera's SxS cards, or ARRIRAW to an external recorder. Usually the decision of which workflow to use is based on control of image in post, budget, turnaround time, and such. The ability to record directly to Apple's 12-bit ProRes 444 with a LogC curve has become a very popular workflow in many feature film and television productions. While the camera can also record Apple ProRes 422 as well as Avid DNxHD 422 and 444 formats, LogC is what allows as much of the sensor's dynamic range as possible to be captured. Because of the QuickTime wrapper to the ProRes codecs, these recorded files can be directly accessed by NLE systems to jump-start the editorial process. Avid Media Composer supports Apple ProRes as a native editorial codec, and can be accessed directly via AMA and consolidated rewrapping the codec to MXF. The same considerations of user or Avid-managed media apply here as with the RED R3D workflow. Even though the codec is native and therefore offers some performance advantages, a transcode or consolidate step needs to be weighed.

An ARRI DNxHD AMA plug-in is needed to ensure that all metadata is being extracted as part of the process (such as long and short Reel IDs); the generic QuickTime AMA plug-in should not be used. (See Appendix D for ARRI Metadata Mapping). The plug-in is available on the Avid AMA webpage. Once the MXF-wrapped Avid DNxHD files are accessed via AMA, a consolidation process to Avid Media can be performed if an Avid-managed media workflow is desired. One of the advantages for AMA before a transcode/consolidate process is the ability to review subclips and select just the required takes, reducing time and overall storage needs.

LogCLUT

How to handle the LogC LUT is another important decision for productions to make, depending on their specific image manipulation workflow needs. Media Composer can directly access the media, but does not offer general LUT insertion as part of the video pipeline, unlike RED's R3D file format, where the color information in the RMD file is being handled by RED's SDK via the AMA plug-in. When LogC or another format is recorded with a color space other than Rec. 709, images will not look "normal" in editorial and therefore a LogC->Rec. 709 LUT is usually applied. If no correction LUT is applied, the images will have a washed out and de-saturated look compared to what is expected because the full dynamic range of the image is being "squeezed" into the chosen codec. After the LUT is applied, the result will have lifted blacks, reduced whites, difference in saturation, etc. which in turn gives the colorist more control later as to what is black or white and what detail stays or goes, gets crushed, and so forth, as part of the creative correction process of the final image.

Avid Workflows for Digital Cinema Cameras



With Media Composer 7, there are two ways LogC images can be handled in an offline/online editorial process:

- Apply a LUT to the clips via Source Settings on one or all selected clips. Source Settings supports 1D and 3D LUTs and color management now becomes part of a real time playback process. Media Composer provides several LUTs as part of the install, but additional LUTs can be added and used as needed. Please see the Media Composer 7 online help for more information.
- Transcode material ahead of time as part of a dailies process to a DNxHD proxy codec such as DNxHD 36 while applying a LogC->Rec. 709 LUT. This can be done with a variety of software solutions at different price points.
- Use ASC CDLs as part of a color correction workflow with a third party dailies system, with or without the use of a LUT.

Additional information from ARRI on using LogC with an ARRI ALEXA workflow can be found [here](#). The ARRI online LUT Generator can be found [here](#). Generating a .cube LUT will work with Media Composer's LUT import (See LUT section).

ARRI ProRes Offline/Online

Creating DNxHD proxy material via a dailies process is the most common method for larger productions as they can benefit from the low storage requirements of DNxHD 36 as well as proper color space of images in an HD offline editorial process. The important consideration here is how the source files are going to be referenced via the dailies creations system. In addition to being tracked in either the Tape or Source File columns within Media Composer, the ALEXA ProRes recording also inserts an 8-character Reel ID in the QuickTime header. Third party dailies systems will always put some form of source filename in the Tape column as only AMA and direct Media Composer import allow sources to be referenced via the Source File column. But what gets inserted into the Tape column and what might be available for an ALE export in these systems is what needs to be planned for and discussed with the entire postproduction team. Some systems will include all the information from the sidecar files available from the recording as either XML or ALE. Other systems only use what is extracted from the file itself, either the embedded Reel ID or the filename, but not both.

Avid Workflows for Digital Cinema Cameras

For example, if using DaVinci Resolve Lite to create native MXF/DNxHD dailies, the Reel ID extraction can be done with the following choices:

- Extraction of an entire or partial filename via expressions
- The folder name containing the media
- Embedded in the file itself
- User defined

Most dailies and DI systems will offer similar types of Reel ID extraction as sources can be from anywhere and it offers flexibility when doing a conform. But when creating dailies, a consistent method is more desirable. In third party applications, the easiest method for ARRI ProRes-recorded material is to use the “embedded” option. If there is a desire to conform in Media Composer or Symphony via AMA to the original ProRes files, then having only the embedded Reel ID as source will not relink to the material, as AMA only uses the entire filename and does not extract any metadata from the QuickTime header. This is not an issue with R3D files as the embedded Reel ID is the same as the Filename. Careful consideration needs to be applied here. As mentioned, some systems will insert both the filename and the Reel ID from ARRI ProRes files into the ALE file that can then be merged to the dailies to have both sources being tracked. If the dailies system does not offer the additional metadata or ALE export, then you can merge the camera-created ALE files, if available to them, into the master clips to have both source IDs available. This is something that needs to be planned on before the editorial process begins. If the final conform is going to be done in a third party system that supports the embedded Reel ID, there is no issue. It's all part of good planning ahead to allow for more flexibility and choices when it comes time to finish.

Media Composer or Media Composer with Symphony Option Finish

A similar Pull List method as described for the R3D workflow can also be used here if finishing in Media Composer or in Media Composer with Symphony Option. The EDL created by whichever chosen method can be imported into a third party dailies or DI system and new MXF/DNxHD media created, with or without LUT or additional color correction applied. This method assumes that most of the color correction and mastering will be done in Media Composer or Media Composer with Symphony Option.

If final color correction is to be done in a third party application, but mastering and output is to be done via Media Composer or with the Symphony Option to Media Composer, it is desirable to color correct in context of the sequence. This is accomplished by exporting an AAF or EDL of the edited sequence to the system of choice. Be aware that different systems have different levels of AAF support and not all systems can conform the complex timelines that can be created within the editing systems, especially if the sequence utilizes plugins that are not support in the color correction program.

Avid Workflows for Digital Cinema Cameras

A consideration for this type of workflow is to do a pre-conform within Media Composer to the original LogC material and transcode to Avid's DNxHD 444 codec. Render any of the effects that are not expected to conform prior to sending the AAF sequence to the color correction system. The AAF will point back to the Avid-managed MXF media and be used for the color correction. From the color correction system, new MXF/DNxHD media is created with an updated AAF. Both of these are brought back into the Avid editing systems for final mastering and output. The MXF media will be placed in the Avid MediaFiles/MXF/ folder structure and the AAF is imported into the bin via File->Import.

ARRIRAW

Productions looking for extra image control with no compression at all can record ARRIRAW. ARRIRAW provides uncompressed image quality and flexibility in the postproduction process. ARRIRAW is uncompressed 12-bit raw Bayer sensor data output from the ARRIFLEX D-21 or ALEXA that needs to be processed before editing can begin. Appropriate equipment and tools are needed to record and work with ARRIRAW, such as an ARRI-approved T-Link recorder. Several solutions are available to record ARRIRAW, such as those from Codex Digital and Convergent Design. All supporting vendors can be found on the ARRIDigital webpage. ARRIRAW is recorded as sequential files with .ari as the extension. An example of a sequence of files would look like:

```
TEST-A02-04_ATA02.0227713.ari  
TEST-A02-04_ATA02.0227714.ari  
TEST-A02-04_ATA02.0227715.ari  
TEST-A02-04_ATA02.0227716.ari
```

Note that the entire file name is 29 characters, thus will need to use the File_32 EDL template if EDLs are to be generated. The camera can also record a ProRes or DNxHD file at the same time as the ARRIRAW files are being created on the external recorders. Many productions choose to record these as 444 LogC, more as a backup to the ARRIRAW files than as a proxy for editorial. Either format will get transcoded via a dailies process, in most cases for productions using ARRIRAW. The camera does not record Avid DNxHD 36 as a proxy format at this time, but storage permitting; DNxHD 115/120 (at 24ps) can be used as the proxy for the ARRIRAW files. The proxy files contain the same filename and metadata so a final conform can easily be done in third party systems back to the original ARRIRAW files. These files can have a Rec. 709 look added to the proxy files while recording as well as any other looks applied at time of recording.

Avid Workflows for Digital Cinema Cameras

When recording with uncompressed RAW formats, the storage requirements are far higher than compressed ProRes or DNxHD formats. To compare, 1TB of storage would hold the following number of hours of picture-only material at 24fps:

Codec	1TB in hours of footage
ARRIRAW	1.82
Apple ProRes 444 (1080p)	9.8
Avid DNxHD 444 (1080p)	5.3
Avid DNxHD 422 (175x) (1080p)	13.24
Apple ProRes 422 HQ (1080p)	13.94

ARRIRAW workflows require a “dailies” process for the offline editorial, due to the amount of storage needed to edit the format natively, as well as the performance needed to do simple effects such as dissolves. Any of the dailies systems mentioned support ARRIRAW and follow the same workflow pipeline as described for ProRes. There is no AMA plug-in for frame-based ARRIRAW camera originals at this time.

Blackmagic Cinema Cameras

A new entrant to the market is the line of Cinema Cameras from Blackmagic Design. These are low cost, high-resolution cameras using a more compressed codec format such as H.264.

The Blackmagic Cinema Camera line can record in three formats (depending on the camera model):

- CinemaDNG (Digital Negative Format)
- Avid DNxHD 10-bit 422 formats (Choice of Film or Video dynamic range)
- Apple ProRes 10-bit 422 formats (Choice of Film or Video dynamic range)

The camera records a 1080p/2.5K/4K 12-bit RAW format (2432 x 1366 or 3840 x 2160), and as with all RAW formats, allows for more control and quality in post depending on production needs. The CinemaDNG is 12-bit Log but the linearization table is built into the DNG headers so CinemaDNG compatible apps will take care of the conversion. A 3D LUT for Apple ProRes and Avid DNxHD files using the Film mode are available in Blackmagic’s DaVinci Resolve 9. The Blackmagic LUT for these cameras used in Resolve can also be used in Media Composer by importing the .cube version of the LUT from Resolve. The camera settings simply refer to it as the Film mode vs Video Mode (Rec. 709). The camera only records one format at a time based on your needs unless using an external recorder. Similar to the ARRIRAW, the recording is a series of sequential files. Storage requirements for CinemaDNG are similar for other RAW uncompressed formats; 1TB will provide 1.98 hours of recorded material. The use of the ProRes or DNxHD recorded formats have already been covered in this document and are also available via the AMA Workflow docs on avid.com.

Avid Workflows for Digital Cinema Cameras

Offline Editing with Blackmagic

Due to the nature of the CinemaDNG format, proxies will most likely be created for offline editorial. The camera, when purchased, includes a copy of DaVinci Resolve, which can process the files into a native DNxHD codec. The CinemaDNG format is also supported by all other dailies and color correction systems, as it is an open format that can be implemented by any manufacturer. Documentation and specifications of the CinemaDNG format can be found [here](#).

The workflow with Blackmagic Cinema Cameras is very similar to the offline process described with either R3D files or ARRI ProRes, but is closest to ARRIRAW due to the sequential frame uncompressed nature of the files themselves.

One of the unique aspects of this camera, compared to the other formats, is the additional metadata that can be applied directly to the recorded media as it is created. Both camera- and user-generated-metadata such as comments, descriptions, scene, take, etc. can be entered and become available to the editors to streamline the logging and identification process. Examples of available metadata in addition to timecode are:

- Manufacturer Type
- Camera ID
- Project Name
- Comments
- Favorite
- Keywords
- Reel
- Scene
- Shot
- Take

Angle

Designation of source name will need to be considered as with the ProRes and ARRIRAW formats, whether it be the entire source filename, or a metadata field embedded within the file itself. For QuickTime, the metadata is embedded as part of the file itself. For CinemaDNG, the metadata is recorded as XML and embedded in the audio file. This metadata will then be used for EDL and AAF generation for the mastering and conform process. The same metadata is also available on either the ProRes or DNxHD recorded files. There is no AMA plug-in at this time that extracts this additional metadata. You can export an ALE from DaVinci Resolve that does include this and merge the ALE into the AMA linked files. See the Media Composer 7 online help for ALE functionality.

Avid Workflows for Digital Cinema Cameras

Working Online with Blackmagic

Neither Media Composer nor Media Composer with Symphony Option directly support the CinemaDNG format, so conform at the native 2.5K resolution will need to be done in a third party conform/DI systems on the market today. A list of manufacturers supporting the CinemaDNG format can be seen [here](#). See the 2K+ Conform section in this document. If you want to maintain the additional frame size to take advantage of the new FrameFlex™ functionality, the online export could be done as Apple ProRes 2K/4K and AMA linked. The additional pixels will then be available to you if needed for the 1920 x 1080 master.

Sony F5/F55

Filmmakers now have more choices for digital cinema production, and in the case of Sony, a range of solutions at different price points to meet different needs and budgets.

The Sony F5/F55 cameras offer HD, 2K, and 4K recording options with both proxy and RAW available to meet your production needs while allowing flexibility in finishing and mastering. As with other high-resolution cameras (2K+), the concept of “super-sampling” for HD delivery creates better images than shooting the same scene at an HD resolution to start. Also, the added resolution can be used to extract a region of interest using FrameFlex™ to correct for framing or objects in the image that shouldn't be there while maintaining the highest resolution possible.

To simplify the following workflow explanation, it will be based on the Sony F55. More information on the camera and downloads for AMA and LUTs can be found [here](#).

The F55 camera offers four internal recording formats. You can choose the image type, codec, processing complexity and file size that match the needs of each project:

- **MPEG-2 HD.** For productions looking for quick, native and fast turnaround for HD television. Format is 50 Mbps at 24p.
- **XAVC HD.** The next generation of H.264/AVC Intra-frame coding offering 90 Mbps at 24p.
- **SR File.** SR has already established itself in tape-based post workflows for its quality and ease of use for postproduction and program exchange. It is offered in two data rates of 176 and 352 Mbps at 24p.
- **XAVC 4K (and QFHD).** Allows for 4K record 4K on to Sony's SxS® PRO+ media internal to the camera (no external recorder needed). 240 Mbps at 24p. QFHD available with a free v1.4 upgrade, (expected December 2013)
- **2K and 4K RAW.** Offering 16bit linear capture up to 14 stops of range. Check with Sony camera specs as to how these formats can be recorded depending on the model.

Avid Workflows for Digital Cinema Cameras

As with any digital cinema camera, workflows will vary depending on the production. For 4K, the files created by Sony are supported in all of the third party dailies systems for production needing the dailies process done as a service. This is typical of feature film and television programming where the workflow pipeline is expecting Avid DNxHD for editorial due to multicam, shared storage, etc., and 4K files are not practical in this environment. In any case, since Media Composer does not support 4K native resolutions, a 1920 x 1080 scaled or proxy version will be used.

Another solution may be to use AMA to directly access the Sony 4K files. These are available by downloading the appropriate AMA plug-in from the Avid AMA landing page found [here](#).

A third solution would be to use the camera generated XDCAM proxies for the higher resolution 4K masters for editorial, then conform back for the higher resolution benefits stated.

As with RED, ARRI ALEXA, and the Blackmagic Cinema Cameras, Sony also provides LUTs that are tuned to their sensor. So while an ARRI ALEXA may use LogC, the Sony cameras use Slog2 gamma that can handle the extended dynamic range now available with the latest F5, F55, and F65 cameras. These LUTs are available for download and are already available in Avid Media Composer 7 (.cube versions). There are currently four LUTs available for download: [Or insert graphic: 013]

- From_SLog2-SGumut_To_LC-709.cube
- From_SLog2-SGumut_To_LC-709TypeA.cube
- From_SLog2-SGumut_To_SLog2-709.cube
- From_SLog2-SGumut_To_Cine+709.cube

If these LUTs are not available in the project, download from Sony and import as per the directions in the LUT section of the Media Composer 7 online help. When using the Sony AMA plug-in, the metadata contained within the files will automatically apply the LUT in Media Composer, if they are installed. You can change the LUT or remove it by going to the source settings for that clip or selection of clips and going to the Color Transform tab of the Source Settings.

Benefits of Proxy Workflows

The quickest workflow for 4K productions is to work with HD proxies. As already mentioned, these can be created in a third party dailies system or by using the XDCAM 50 Mbp/s proxy already recorded by the camera. A quick word of caution when accessing the proxy files directly from the card is that this does not ensure the integrity of the 4K files. As with any camera and recording format, issues can arise with the file, either during recording, or during a copy. When using the 4K files to make the proxies as with a dailies system or a transcode of the 4K files via AMA, the process includes a form of QC on those files. A quick tip is to open the 4K files in either the Sony Browser application or other application to ensure they play back before handing the card or drive back into the production cycle.

When the proxy and the 4K files are recorded at the same time, they contain the same Source ID so an offline to online relink works seamlessly.

Avid Workflows for Digital Cinema Cameras

The following will detail the workflow for XDCAM proxy + 4K XAVC and XDCAM proxy + 4K Sony RAW in a post process.

XDCAM Proxy and 4K XAVC

The advantage of 4K XAVC shooting is that a proxy can be recorded at the same time on the same card. This facilitates the production workflow by keeping everything in one camera.

The recommendation when shooting 4K XAVC productions is to not use the XDCM proxies as the conform process will involve many file renaming steps in order for Media Composer to match the proxy with the 4K master file. Use AMA to link to the 4K files, or use DMF to create proxies to ensure proper source/reel tracking.

AMA uses the entire filename as the Source/Reel ID in the “Source File” column. They need to match as much as possible as Media Composer does not offer much control over reel identification with syntax control as you may find in dedicated conform processes of DI color correction systems.

4K XAVC filename: B001C001_1308213D.MXF

XDCAM Proxy filename: B001C001_1308213DS02.MXF

Notice the addition of S02 at the end of the file. This is currently used to identify the clip as the XDCAM proxy. Because the filenames are different, a relink conform process is not possible. Media Composer only offers the following modifications to the conform process:

- Ignore characters after last occurrence of (enter text string)
- Ignore extension (check box)

Using “ignore characters after last occurrence” can be problematic as the filename may have a name such as B001C001_1308213SS02.MXF where there are two S' in a row. The workaround involves the following steps:

1. Duplicate Source File column for all files into the Labroll column (or another column if Labroll is already being used)
2. On the proxy clips that have the S02 at the end, enter an underscore to separate it from the filename as is B001C001_1308213D_S02.MXF.
3. Select all the 4K clips and the sequence. They do not need to be in the same bin. With everything highlighted, right-click on the sequence and select “Relink”
4. Check “Selected items in ALL open bins”
5. In the “Relink by:” section for Original:
 - a. Timecode = Start
 - b. Source Name = Labroll
 - c. Ignore extension = active (checked)
 - d. Ignore characters after last occurrence: = “_” (underscore)

Avid Workflows for Digital Cinema Cameras

6. In the “Relink by:” section for Target:
 - a. Timecode = Start
 - b. Source Name = Labroll
 - c. Ignore extension = active (checked)
 - d. Ignore characters after last occurrence: = (blank)
7. Click OK. It is helpful to set a source clip color on the 4K clips to verify the conform process in the timeline when complete. See the Media Composer 7 online help for more detail on setting source color and viewing in the timeline.

This workaround can be process intensive if you have a lot of clips to manage. One can use a text editor to do a search and replace of an ALE file and merge that back into the clips. Be aware that the ALE file must contain all the columns of metadata you want to preserve, as the merge is not a true merge, but more of a replace function. See the Media Composer 7 online help for ALE merge functions.

The Sony LUTs are already imported they will not automatically be applied to the proxy clips, but will be to the 4K XAVC. Also note that currently, when AMA linking to the 4K XAVC clips that have a 1.89:1 aspect ratio, Media Composer does not default to Letterbox, but will do a “fit.” In order to see the entire image, select all clips, and select “Letterbox/Pillarbox” in the Reformat column.

XDCAM Proxy and Sony RAW

The proxy and Sony RAW workflows offer more control in image quality and unlike the XAVC/proxy workflow, will work with no file naming modification needed. As seen in graphic xxx, the filenames for both proxy and master are the same, streamlining the relink/conform process. In this case, the settings in the relink will be:

1. Select all the 4K clips and the sequence. They do not need to be in the same bin. With everything highlighted, right-click on the sequence and select “Relink”
2. Check “Selected items in ALL open bins”
3. In the “Relink by:” section for Original:
 - a. Timecode = Start
 - b. Source Name = Tape or Source File (second menu entry)
 - c. Ignore extension = active(checked)
 - d. Ignore characters after last occurrence: = (blank)
4. In the “Relink by:” section for Target:
 - a. Timecode = Start
 - b. Source Name = Tape or Source File (second menu entry)
 - c. Ignore extension = active (checked)
 - d. Ignore characters after last occurrence: = (blank)

Avid Workflows for Digital Cinema Cameras

5. Click OK. It is helpful to set a source clip color on the 4K clips to verify the conform process in the timeline when complete. See the Media Composer 7 online help for detail on setting source color and viewing in the timeline.

Ignore extension is active in this scenario because the proxy file has an uppercase .MXF while the 4K master file has a lower case .mxf. One could also uncheck the "Match case when comparing source names."

When editing with proxies in this scenario the 1.89:1 aspect ratio is baked into the image file so Media Composer is unaware of where the active picture pixels lie. If using FrameFlex™ on the proxies, and later conforming to the camera 4K masters, the region of interest will be off by 1.89:1 to 1.78:1. If the production anticipated a lot of reframing and image extractions as part of the editorial process, then it is recommended that the proxies are made directly from the 4K SonyRAW masters as Media Composer will then know the boundaries of the active picture within a 16:9 frame.

LUTs again will automatically be applied to the camera masters and not the proxies. Select all the proxies and go to Source Settings where a LUT can be applied to all of them in a single step.

2K+ Conform

Productions that need to conform at the native resolution of the camera originals, or higher than HD, will need to look to third party systems that support these types of resolution.

The market has seen an explosion of mastering tools over the past few years at price points available to all. DI, or digital intermediate, has expanded its feature set to not only be color correction for high-end features, but to also reach into other markets such as broadcast, cable, and independent productions. Each version increases the levels of conform available, targeting a more seamless conform process. A list of solutions can be found in Appendix A.

Using EDL vs AAF

EDL Conforming

The two interchange methods for conforming in these systems is either an EDL or AAF. Depending on the system, AAF is usually the preferred method, but mileage may vary between vendors depending on complexity of timeline with VFX, plug-ins, nested elements, and such, and the depth to which the third party system has for parsing the information. Avid provides for an XML presentation of the sequence. It is a more specialized version that is based on Avid FilmScribe and is not for conform, but more as a sequence breakdown to parse elements in a database or as part of a pull process prepping elements in a DI type workflow. Information on the XML schema and dictionary can be found on the Avid FilmScribe information page.

Avid Workflows for Digital Cinema Cameras

When all else fails, the CMX3600 EDL is used, but that comes with its own set of limitations based on the specifications of a now ~40 year old format. In order to remove some of these limitations, Avid EDL Manager offers two EDL templates: File_16 and File_32. Although the overall format is based on a CMX EDL, it has removed the following limitations:

- Character limit of source reel. CMX3600 only allowed up to 8 characters. File_16 and File_32 by name indicate the number of source characters allowed in the EDL. This supports the longer filenames now used as source with cameras such as RED, ARRI, and SI-2K, as well as VFX workflows where versioning becomes part of the filename.
- Number of sources. CMX allowed up to 256 sources per EDL. While tape-based formats allow up to 24 hours of footage to be associated with a single source ID, each file is its own source SD with file-based media. Because every take is a unique source, it can easily add up to thousands of sources in a single project or timeline.
- Number of events. CMX limited the number of events of a single EDL to 999. These new templates have upped the event count to 9,999.

Most, if not all, vendors have made changes to allow these types of EDLs to be imported and used for the conform process.

In Media Composer, the following columns can be used for source identification in an EDL depending on where that source file name is being tracked:

- Tape
- Source File
- Labroll
- Camroll
- SoundRoll

As mentioned earlier, depending on how dailies got created (via third party system, direct tape capture, or AMA/Import), the source identification will most likely fall into either the “Tape” or Source File” column in the bin. Since an EDL has to have some form of Reel ID, Tape and Source File are combined as the default setting for EDLs. The result is that EDL Manager will first look for a value in Tape and uses that; if none is found, it will look to Source File. If you do not make any modification to the sources, there will never be a value in both columns at the same time; it is either one or the other.

In some scenarios, a version of the source file may exist in either Tape/Source File and in a column such as Labroll or Camroll. This is due to the fact that some cameras such as RED and ARRI ALEXA will provide an 8-character version of the filename to either support a legacy CMX3600 EDL format or NLE systems that do not track and generate full filenames in the EDL. In these scenarios, the “8 character” Reel ID can usually be found in either the Labroll or Camroll columns.

Avid Workflows for Digital Cinema Cameras

An example of an ARRI ALEXA ProRes recorded file will have the two file names available for the same file:

- A064C001_120524_R2G4
- A064R2G4

The longer filename will be tracked in either the Tape or Source File column, while the shorter 8-character version will be in either the Labroll or Camroll column. How and where these file names get tracked is based on a variety of factors: where vendors choose to track them, where software solution providers decide to track them, and in the end, where the individual user wants to track them. The strength of Media Composer's metadata management allows for all formats of source tracking to be managed and output in either EDLs or AAF as needed in the postproduction pipeline.

AAF Conforming

AAF (Advanced Authoring Format) is an open standard originally initiated by Avid, but quickly adopted by many vendors, and an association was created. The association is now called the Advanced Media Workflow Association (AMWA) and anyone can join and participate in the definition of the open standard.

There are two types of AAF export available in Media Composer and Symphony: AAF and AAF Edit Protocol. AAF Edit Protocol is a subset of the AAF, as its primary goal is to establish a well defined, albeit more constrained, set of the AAF to ensure 100% compatibility between vendors. An AAF Edit Protocol may not support all the latest VFX and layer/nested elements in a composition. As such, it sits between an EDL (most basic representation of a sequence) and AAF (most rich representation of a sequence). Media Composer 7 now has the ability to export an AAF even when sources are AMA linked. In previous versions, you needed to select "edit protocol" in order to export an AAF file with AMA sources. This also eliminates the workaround of having to open EDL Manager first, navigate to the bin, and work from there. You can now use "get sequence" for EDL generation.

Some third party systems do not recognize conforming sources being tracked in the Source File column when using AAF as legacy workflow and vendors' implementations have always been to track sources in the Tape field. If this scenario presents itself, generating an EDL will solve the problem at the risk of losing some of the supported additional VFX metadata.

AAF export presents a variety of options, but when referencing the original camera assets and not the MXF proxy, a "link to" is all that is needed. Additional management is based on track selection as well as spans within the track, depending on conform needs at the time of generation. For example, just the video tracks may be sent to a DI color correction system, while an audio-only AAF is sent to an Avid Pro Tools system. There are no further options to select, as all related metadata of the sources and sequence creative decisions are in the AAF file.

Before generating the AAF, you may want to simplify the sequence, especially in the case of multicam sources. Instead of sending all the sources, whether they were used or not, the sequence can be optimized to remove the group information and only reference the camera angle/take used in the final sequence.

Avid Workflows for Digital Cinema Cameras

Both LUT and FrameFlex metadata are being added to AAF and will be available to third parties. DaVinci Resolve 10.1 now supports FrameFlex extraction metadata. Please contact the manufacturer for any updated information.

Summary

Media Composer's ability to track multiple sources and timecodes, combined with AMA and open standards such as MXF, AAF, and DNxHD, give productions the most flexibility in the postproduction pipeline. Finishing and mastering can be done directly within the Avid products, or easily transported to third party systems, or a hybrid between the two. The editorial process may seem complicated at first when dealing with high-resolution formats, but careful planning should head off any issues that may arise. Consult with all parties involved in both the production and postproduction process for picture and sound to ensure that everyone is on the same page before the cameras roll, or in the file-based world, before the production capture process begins.

Avid Workflows for Digital Cinema Cameras

Appendix A: Color Correction and Dailies Systems

- (B) Both
- (D) Dailies
- (C) Color correction
- (B) Assimilate Scratch color corrector
- (C) Autodesk finishing, VFX and color grading systems
- (B) Blackmagic Design DaVinci Resolve
- (B) Mistika finishing, compositing, stereo 3D and color grading system
- (C) Digital Vision/ Nucoda Film Master color corrector
- (B) FilmLight Baselight color correction system
- (D) Gamma and Density 3cP on-set color correction system
- (C) Adobe SpeedGrade color corrector
- (C) Pandora Revolution color corrector
- (C) Synthetic Aperture Color Finesse
- (D) YoYotta YoYo
- (D) Flexity, BonesDailies DFT, Digital Film Technology Weiterstadt

Appendix B: AAF Resources and Information

AAF Edit Protocol Overview:

http://www.amwa.tv/past_events/ibc2005/aaf.edit.profile-web.pdf

Edit Protocol Specification:

<http://www.amwa.tv/downloads/specifications/aafeditprotocol.pdf>

AAF Effects Protocol:

http://www.amwa.tv/downloads/specifications/AS-05_AAF_Effects_protocol_v1.pdf

Avid editing products do not support the AAF Effects Edit Protocol at this time.

Avid Workflows for Digital Cinema Cameras

Appendix C: Red Camera Metadata Mapping

Name	A118_C004_11022S
Tape	A118_C004_11022S
Camera	A
Clip	C004
Start	13:08:32:10
Original_Start	13:08:32:10
End	13:09:58:09
Original_End	13:09:58:09
Auxiliary TC1	01:03:44:17
Tracks	VA1A2A3A4
DPX	A118_C004_11022S-000000
Shoot Date	20101102
Filename	A118_C004_11022S
TimeStamp	171059
FrameWidth	4096
FrameHeight	2304
ColorSpace	3
GammaSpace	7
Kelvin	5503
Tint	-9.8
ISO	500
Exposure	0.473
Saturation	1
Contrast	0
Brightness	0
GainRed	1
GainGreen	1
GainBlue	1
Black X	0
Black Y	0
Toe X	0.18
Toe Y	0.07
Mid X	0.5
Mid Y	0.5
Knee X	0.755
Knee Y	0.83
White X	1
White Y	1
CamRoll	A118_C004_11022S

Avid Workflows for Digital Cinema Cameras

UNC

D:/MissingWilliam/RedMaster_110210_06/A118_1102P6.
RDM/

A118_C004_11022S.RDC/A118_C004_11022S_001.R3D

Labroll

A118C004

BWF Creation Date

39022

SoundRoll

MW_17029.WAV

Sound Filename

D:/Test Files/MissingWilliam/Deva Audio Master_110210
Day17/MW_17/MW_17029.WAV

Sound

13:08:32:10

Sound TC

13:08:32:10

Sound Offset

0

Sound Slate

737753

Video Slate

74

Sound Scene

A28

Sound Take

3

Sound Note

Scene

A28

Take

3

Avid Workflows for Digital Cinema Cameras

Appendix D: ARRI ALEXA Metadata Mapping

For OS X users, there is a simple Clip Meta-View application that allows viewing and exporting of ARRI Look Files from one or more ARRI ALEXA-recorded ProRes files. It is available from the Apple Store. If the original camera XML or ALE file was lost in the process, it can be generated again using the ARRI Meta Extract tools via command line. These are saved out as .csv files which can be turned into ALE files with some basic text editing. See the [Avid Metadata Logging and Management Whitepaper](#) available here. (resent with this whitepaper for Avid to reference again on website)

Avid Workflows for Digital Cinema Cameras



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