ALEXA

MXF/DNxHD with SUP 9.0

WHITE PAPER

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1. Version History/Last Changes

Version	Author	Change Note
2012-03-06	Temmler	Changes to Consolidate step 4, added Chapter 5 Avid DS.
2012-04-05	Temmler	Changed 2.3 Log C information, 6. Viewing MXF/DNxHD files and 7. Downloads
2013-12-03	Grafwallner	New DNxHD 444 codec available in SUP 9 camera update

2. Table of Contents

3. Introduction

ALEXA Software Update Packet (SUP) 9.0 allows in-camera recording of 1920 x 1080 (16:9) Avid DNxHD encoded MXF files onto SxS PRO cards for ARRI ALEXA and ALEXA Plus cameras and for ALEXA XT/XR cameras onto XR Capture Drives, SxS PRO and CFast 2.0 cards.

With an installed DNxHD license, ALEXA users can choose MXF/DNxHD in addition to the pre-installed QuickTime/ProRes recording codecs. ALEXA's MXF/DNxHD material can be edited in Avid Media Composer Version 5.5 and later for Apple and Windows 32 and 64 bit operating systems without transcoding.

This paper gives a short description of the available codecs and provides instructions on how to work with ALEXA DNxHD material in the Avid environment.

3.1 Avid DNxHD

The Avid DNxHD HD codec has been engineered to create mastering-quality HD media at dramatically reduced file sizes without generation loss during complex post production effects processing. Avid DNxHD delivers both efficiency and high image quality. The source for the Avid DNxHD codec can be licensed free of charge and the codec is compliant to SMPTE VC-3.

3.2 MXF OP1a

Avid adopted the MXF (Material eXchange Format) standard as the core media container technology for nonlinear workflows. An MXF container file can "wrap" different types of video and audio material along with associated metadata. The internal structure of MXF files is defined by the so-called Operational Patterns.

ARRI ALEXA cameras record DNxHD encoded images together with sound and embedded metadata in an MXF container file using the Operational Pattern 1a (OP1a) file structure. An Avid Media Composer does not need to transcode this material, as it already is available in a native DNxHD codec. In a common Avid infrastructure with shared media, Avid products expect files to be re-wrapped using the OP-Atom MXF format, which is optimized for nonlinear editing. Nevertheless, there are a number of reasons that prompted us to choose the OP1a file structure for recording in ALEXA cameras:

- The OP1a MXF format packages picture, sound, and metadata in a single file. This is ideal for both camera acquisition and archiving since audio and video is always kept together and no data is lost if recording is interrupted for any reason.

- OP1a is a streaming format, which means that even incomplete files can be played. This does not only ensure highest data safety but also allows playing clips that are still being transferred (eg. via FTP).

- The OP-Atom MXF format places picture and sound into individual MXF files. Audio is written after video. Using this format for recording in a camera would cause entire takes to be corrupted if the recording is interrupted abnormally, e.g. due to a power loss.

- When ALEXA clips are brought into Avid Media Composer, Newscutter, or Symphony, the OP1a file structure enables that camera metadata is automatically made available in the editor's bins.

- Since ALEXA MXF files use Avid's native DNxHD codec, the OP1a files can be quickly repackaged to the OP-Atom format. This is essentially a copying process since no transcoding is involved. The original image quality is fully retained. Note that ALEXA uses high quality intraframe codecs, which result in bigger files than material encoded using a lower quality interframe long-GOP codec. Therefore, copying times will increase approximately by the ratio of the bit rates.

- The DNxHD codecs, MXF files and OP1a structure used by ALEXA cameras are all compliant to existing SMPTE standards.

- OP1a MXF files are the primary acquisition and archiving format for many broadcasters. Being able to deliver this straight out of the camera has a lot of potential in terms of cost-savings.

4. What's new with SUP 9.0

4.1 DNxHD 444

The new recording format DNxHD 444 is a 10bit codec and is available for all cameras with a DNxHD license. The codec is developed in close collaboration with Avid and delivers high color fidelity and image quality, which provides an excellent basis for creative grading, color keying and multi-generational finishing and mastering. DNxHD 444 clips can be recorded at up to 30 fps on 32 GB SxS PRO cards and up to 60 fps on 64GB SxS PRO cards, CFast 2.0 cards or XR Capture Drives. Higher frame rates will be possible with a later camera software (SUP).

4.2 New ARRI MXF AMA Plug-in 1.5

A new MXF AMA Plug-in is available for DNxHD 444 .mxf files in Media Composer 7.0 Windows and Mac.
www.arri.com/alexa/downloads.

4.3 New Color Management features in Media Composer 7

The new ARRI MXF AMA plug-in 1.5 enables an automatic 3D LUT selection for Log C DNxHD material recorded with ALEXA SUP 9.0 or higher.

When this DNxHD Log C footage will be linked into Media Composer 7.0.3 thru the ARRI MXF AMA plug-in 1.5, automatically the correct "ARRI ALEXA LogC to Rec709" color transformation 3D LUT will be applied onto the clips. The Log C images will be displayed in video color space "Rec 709" during real time playback in the Source and Record monitor of the Media Composer. The tab "color encoding" in the Source Settings… dialog box allows to set the correct color transformation LUT manually if necessary.

For more information about the new Media Composer color management, please check the Avid Media Composer Help.

5. DNxHD Recording

5.1 Licensing

The ARRI ALEXA Studio / Plus 4:3 and ALEXA XT Studio / Plus do not require a special DNxHD license. It is delivered with all functions enabled. For all other ALEXA models, the DNxHD recording option can be enabled with a license key that needs to be purchased for each individual camera in the ALEXA License Shop at http://alshop.arri.de/. The DNxHD recording option can be activated and de-activated by loading or deleting the license file on the camera. This allows rental facilities to rent out cameras with or without the feature.

5.2 Available Codecs

SUP 9.0 provides three flavors of the DNxHD codec

- Avid DNxHD 145   (8 bit 4:2:2)
- Avid DNxHD 220x (10 bit 4:2:2)
- Avid DNxHD 444   (10 bit 4:4:4).

The values 145 and 220 denote the bit rate [Mbit] at 29.97 fps. As the supported project frame rates are 23.976, 24, 25 and 29.97 fps, the notation for these codecs we have chosen in the ALEXA menu is (in **bold**)

- **Avid DNxHD 115/120/145**   (8 bit 4:2:2)
- **Avid DNxHD 175x/185x/220x**   (10 bit 4:2:2)
- **Avid DNxHD 444** 350x/365x/440x   (10 bit 4:4:4).

5.3 Rec 709 and Log C

Shooting ProRes or DNxHD encoded material with the ALEXA Rec 709 curve delivers a picture that is ready-to-use for edit or broadcast. It is the quickest route from scene to screen, but it does not provide a lot of space for color timing.

Recording the images in Rec 709 including the Low Contrast Curve (LCC) ARRI Look File (available as a free download on http://www.arri.com/goto/downloads/alexa) will hold some more highlight detail. The softer tonal curve requires that the picture will be touched for final output, but this is as simple as a contrast adjustment.

Shooting images in Log C delivers the best foundation for the colorist's work, providing the camera's full latitude in an unconfined color space. For output on HDTV or in a DCI P3 projection, Log C images need to be tone-mapped and transformed into the display color space. This is typically done using a 3D LUT provided through the ARRI LUT Generator at http://www.arri.de/camera/digital_cameras/tools.

Please note:
Log C material is best recorded using a 4:4:4 codec (ProRes 4444 or DNxHD 444).
The top quality 10 bit 4:2:2 codecs (ProRes 422 (HQ) and DNxHD 220x) will also provide acceptable results in Log C, but due to the higher compression rate, grading images recorded with these codecs may exhibit artifacts.

ARRI strongly recommends to use 4:4:4 codecs for shooting Log C to avoid artifacts in graded images.

5.4 Media Structure

When an ALEXA starts recording the first take, the SxS PRO or XR Capture Drive is named according to the current camera reel name (e.g. A016R1K4). The camera then creates a reel folder with the same camera reel name in the root directory of the card, which stores the MXF (and/or QuickTime) files, a Final Cut Pro 7 XML file and an Avid Log Exchange (ALE) file.

5.4.1 File Names

The file-naming scheme is identical for QuickTime and MXF files. Only the file suffix differs.

```
A016C001_120126_R1K4.mxf
```

[CameraIndex] [ReelCounter] [ClipIndex] [ClipCounter] _ [Date] _ [CameraID] . mxf

CameraIndex: 1 letter camera unit identifier, assigned by user: A-Z.
ReelCounter: 3 digit counter, auto-incrementing for each new card.
ClipIndex: Letter 'C' for clips 001-999. If there are more clips, the index continues with D.
ClipCounter: 3 digit counter, auto-incrementing for each new clip.
Date: Current date set in camera menu: YYMMDD.
CameraID: L or R eye index, default R, followed by 3 digit, Base36 encoded, camera serial number.

5.4.2 Final Cut Pro 7 XML and Media Composer ALE File

While all static metadata is embedded into each recorded clip, the Final Cut Pro 7 XML file and the Media Composer ALE file provide a summary of all recorded takes with related metadata such as:

```
Clip Name: IN/OUT Time code, Duration, FPS, UUID, Sup_Version, Exposure_Index,
Sxs_Gamma, Whitebalance, Cc_Shift, Look_Name, Look_Burned_In, Sensor_Fps,
Shutter_Angle, Camera_Model,…
```

6. ALEXA DNxHD Material in Avid Media Composer

ALEXA DNxHD material is brought into Avid Media Composer using Avid Media Access (AMA). The camera material can be directly edited without the need for transcoding.

Note: It is not possible to directly drag and drop ALEXA material into an Avid bin.

6.1 About Avid Media Access (AMA)

AMA is a plug-in-based feature in Avid Media Composer, Symphony, and NewsCutter software that is used to link the camera material into an editor's bin(s) without creating a copy on the Avid storage. This gives the editor immediate and direct access to all clips just as if they were stored in the Avid Media Files folder.

For more information on AMA, please visit http://www.avid.com/US/products/Avid-Media-Access.

ARRI provides a free Avid Media Access (AMA) plug-in for the Mac version and the 32 and 64 bit Windows version of Media Composer 5.5, 6.0 and for 7.0.

The recent Mac or Windows ARRI AMA plug-in version 1.5 for the DNxHD 444 support in MC 7.0 can be downloaded from http://www.arri.com/alexa/downloads.
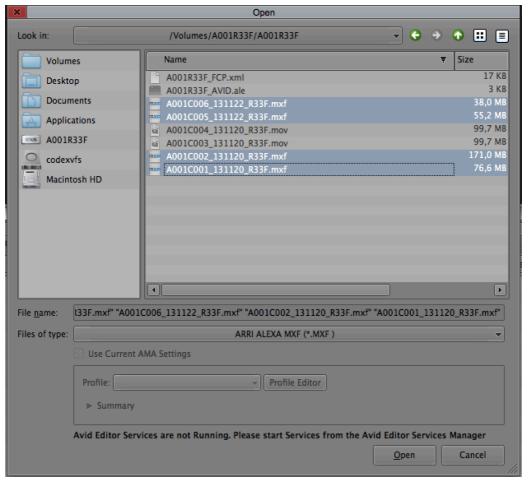
6.2 Editing with AMA Clips

The AMA plug-in for ALEXA allows linking to individual MXF files or linking to a volume (or folder structure) containing those files. The linked clips are automatically brought in with all available camera metadata.

Note: While linking to an SxS card CFast 2.0 or Codex capture drive is possible, an editor typically would not receive the original cards, but an external drive containing verified copies of several original camera cards.

6.2.1 Linking to Files in MC 7.0

Individual clips can be linked into the active bin.

1. Right-click inside the bin and select "**AMA Link..**

2. In the file browser, go to a camera reel folder (e.g. A003R1K4) and select the MXF clips.
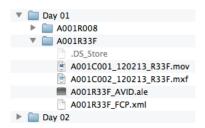

3. Select (Enable) "**ARRI ALEXA MXF (*.MXF)**" from the Files of type filter menu and click 'Open'. If the reel folder also contains QuickTime clips, they need to be linked in a separate step with "**QuickTime"** selected.
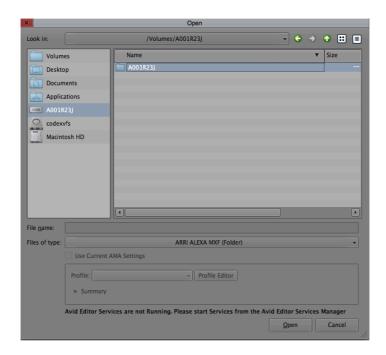

6.2.2 Linking to a Volume

While the organization of clips, of course, is entirely up to the editor's preference, there are a number of options how clips can be automatically pre-organized as they are linked by AMA.
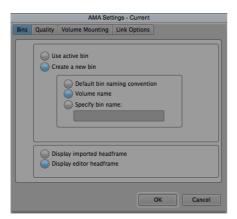
In the following example, a drive containing camera reels is arranged into individual folders per shooting day.

1. Use "**File > AMA Link..**" to open the file browser.

2. Select (Enable) "**ARRI ALEXA MXF (Folder)**" from the Files of type filter menu and click 'Open'. If the reel folder also contains QuickTime clips, they need to be linked in a separate step with "**QuickTime**" selected.

Use Current AMA Settings, uses the AMA Settings from the Settings tab,

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6.3 Editing with Consolidated Clips

The Avid workflow uses a special MXF Operational Pattern (OP), i.e. a MXF file structure, that was designed to deliver the best performance for nonlinear video and audio editing applications. In this file structure, called OP-Atom, the video and audio tracks of a single movie clip are stored in individual MXF container files along with an index that will retain the clip metadata across the related track files.

While OP-Atom performs extremely well for authoring applications such as nonlinear editing, the structure is less suitable for recording a stream of data in a digital camera. If, for example, the camera were disconnected from power during recording, the entire clip would be corrupted. OP1a, as used by ALEXA cameras, is a streaming format that is intended for this type of application. Upon a power loss, only a few missing frames at the end would go missing instead of the entire take.
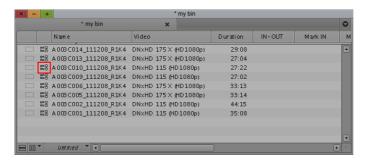
Depending on the project, ALEXA material that is edited from a single Media Composer could remain in the originally recorded OP1a MXF format. If, however, several editors will work on the material simultaneously, or if the amount of clips that will be accessed for editing were to exceed several thousands of clips, it is recommended to convert the material into OP-Atom MXF files.
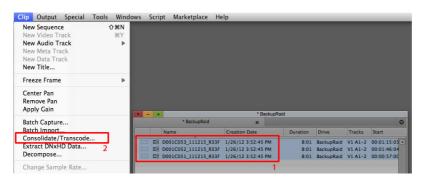
Please note:

Converting the MXF container format does not require transcoding of the ALEXA material. The essence streams only need to be **consolidated**, i.e. separated and re-wrapped into individual files. The speed of this process greatly depends on the speed of the interface and storage used to read/write the media files.

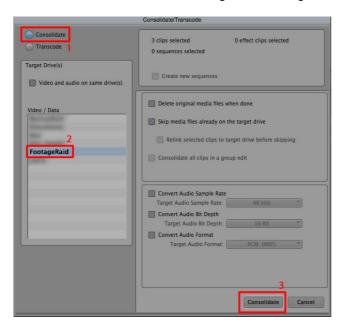### 6.3.1 Consolidating AMA-linked Files

1. Linked clips are shown in the bin with a link icon.
   Select the ALEXA clips that were linked with the AMA plug-in or a sequence containing the clips.

2. Select Clip > Consolidate/Transcode.

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3. When the Consolidate/Transcode window opens, check '**Consolidate**' in the upper left corner and select the **Target Drive(s)** where the re-wrapped version of the files will be created. Click the '**Consolidate**' button in the lower right corner to get to the next step.
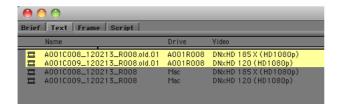

4. If you consolidate ALEXA MXF/DNxHD clips, you typically want to access the OP Atom version in the future, rather than the original camera material. Select "**Relink Master clips to media on the target drive**". The clips names in the bin (e.g. A001C001_120212_R1K4) will then point to the consolidated version on the target drive (typically the Avid Media Files folder). For the original files, new links will be created in the bin with the suffix ".old" attached to the original filename.

   If the other option is selected, the links to the original files are kept and the consolidated version will be named with a suffix ".new". This creates a problem, for example, when you try to conform to an Avid DS, as the DS will try to locate the clips based on the name in the AAF metadata, which carries the original clip name rather than the .new name. We therefore recommend to use the relink option.

5. When you start the process, the clips in the bin will point to the new files and the newly created ".old" links will point to the original camera material.

7. ALEXA DNxHD Material in the Avid Interplay Environment

Avid-based Broadcasting and media production infrastructures use centralized media storage such as an Avid ISIS 5000 or 7000 (or before Unity) or at least a simple shared storage and manage their media files with the Avid Interplay Production system.

7.1 About Avid Interplay

Avid Interplay is a production asset management system that maintains a central database containing all current project information and working media for collaborative access in a production or broadcasting environment. Interplay keeps track of all assets (gathered material and versions thereof, graphics as well as bins and sequences from the editing applications) that are used in a production, from creation to archive. For example, material that is available in multiple resolutions on the shared storage can be linked to a lower resolution during editing to save on bandwidth and processing power and then be relinked to the higher resolution original media for finishing and delivery.

7.2 Preparing ALEXA Material for Interplay

There are several ways to ingest material into an Avid Interplay infrastructure, from different ingest stations and transfer services to the recently introduced AMA plug-ins. The best way to ingest ALEXA MXF/DNxHD files into an Avid Interplay environment is to use the ALEXA AMA plug-in for Avid Media Composer.
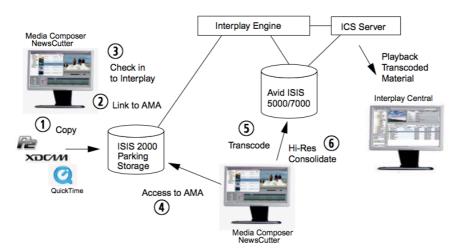
As mentioned above, Avid systems use a media file structure (MXF OP-Atom) that is optimized for the specific needs of nonlinear video and audio editing. In case of Interplay, the use of OP-Atom is mandatory, as the indexing service that maintains the database will only accept media in this format.

7.2.1 Checking AMA Clips into Avid Interplay

1. Link the ALEXA MXF OP1a clips to a new Avid Media Composer bin using the ALEXA AMA plug-in as explained above.
2. Consolidate the material within the original AMA bin to create MXF OP-Atom files as explained above.
3. Drag and drop the resulting non-AMA clips into a new bin.
4. Check the new bin into Interplay.

7.3 Preparing ALEXA Material for Interplay V3

One way to handle this was to consolidate the recorded AMA media to native MXF files on the ISIS system associated with the Interplay production environment (such as an ISIS 5000 or ISIS 7000). The AMA workflow introduced in Interplay v3.0 uses a second, low bandwidth ISIS 2000 as a parking storage area for the AMA media. Later, when the material that should be saved is identified, it can be consolidated from the AMA source to the ISIS production system at full resolution.

For more information about the Interplay 3.0 workflow, please check the documentation from Avid.
http://resources.avid.com/SupportFiles/attach/Whats_New_Interplay_V3_0.pdf

8. ALEXA DNxHD Material in Avid DS

Avid DS is a hardware/software system that is used to edit, composite or finish media. When DS is used with ALEXA MXF/DNxHD material, there are a few things to keep in mind:

1. Use an AAF file to send the edit from the Avid Media Composer to the DS. EDLs cannot provide sufficient information.
2. Re-wrap/consolidate ALEXA MXF files to OP Atom. DS has no support for the OP1a file structure as recorded by the camera. Transcoding, however, is not required!
3. Re-wrapped/consolidated clips MUST have the name of the original camera clips e.g. A001C001_120212_R1K4 or the DS will not be able to find the files. The consolidate process will append a suffix ".OLD" to the original clips. Also see instructions above.
4. Make sure that you are using compatible Avid Media Composer and DS versions. http://aviddssupport.avid.com/index.htm?section=configurations/10.5.htm

More information about conforming to an Avid DS can be found in the Conform Guidelines: http://aviddssupport.avid.com/pdf/v10.5/AvidDS_Conform.pdf

9. Viewing MXF/DNxHD Files

There are free player available that allows viewing the MXF files outside of Avid Media Composer. To enable MXF playback, you will need:

MXF Import QT (Mac only)
http://www.hamburgpromedia.com

or

Calibrated{Q} MXF Import (Mac or PC)
http://www.calibratedsoftware.com (version 2.1.2 or later)

and

the current Avid DNxHD codecs
http://avid.force.com/pkb/articles/en_US/Compatibility/en263545

10. Downloads

The ARRI AMA Media Composer Plug-in for Mac OS and 32 bit or 64 bit Windows can be found in the digital camera download section at www.arri.com/alexa/downloads.

11. Contact

In case you have questions or recommendations, please contact the Digital Workflow Solutions group within ARRI via email: digitalworkflow@arri.de.