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2K Overview

Understanding 2K Workflows in Today's Post-production Evironments

The Image Size of 2K: *Traditional Cinema* and *Digital Cinema*

2K is a term, like SD and HD, used in today's post-production environment to describe a particular image size and quality of data. 2K data exceeds our pre-existing television broadcast standards for both SD and HD and is therefore most commonly associated with traditional cinema and the emerging digital cinema initiative.

When working with data for eventual cinematic projection, FX work or digital intermediate purposes, 2K is usually defined as 2048x1556 pixels. This size represents the "full" size of the 35mm film between the sprockets. Therefore the result, 2048x1556 pixels, appears as a 4x3 image when compared to an HD image which is typically 16x9. In 2K, other image sizes can be derived from this 2048x1556 source by taking a cropped portion of the image for use. For a traditional cinematic projection scenario, the final delivery of this 2048x1556 data is onto 35mm film. The film undergoes photochemical and mechanical processes before the image reaches the screen.

The other common size attributed to 2K is 2048x1080; this is the standard to which digital cinema currently adheres. Most digital cinema projectors have this 2048x1080 image size as a supported resolution and in many cases, as a maximum resolution. Here the data at 2048x1080 need not undergo a photochemical process; it can stay data for its path to projection.

So the first obvious advantage of working with 2K images as opposed to HD is the size of the image that can be generated, manipulated, and ultimately projected. Some will argue that a better choice for cinematic work is a 4K resolution. Certainly this is true, but working with 4K would be exponentially more of a burden than working with 2K's already large data requirements; 4K is simply beyond the scope of many pieces of equipment be it scanners, storage or projectors. To be fair, some 4K and beyond resolution is already being performed for select feature films—and even then for select shots in many cases. Perhaps in the future 4K will supplant 2K as HD is replacing SD, but that day seems to be quite distant, so for now a large body of the motion picture community has settled on the high quality of 2K.

2K Color: More Like Film than Video

2K images, like SD and HD images, can come in 8 bit, 10 bit, 12 bit, 16 bit etc. But most commonly, 2K files are in written in a 10 bit Log RGB or RGB format. This provides for 1024 gradations of a given color in three equivalent colors of red, green and blue. By using RGB, 2K data can emulate, to some extent, film which achieves its color reproduction via red, green and blue layers of emulsion.

The actual 2K image sizes of 2048x1556 and 2048x1080 are usually written in two similar, but slightly differing, file formats; Cineon or DPX (Digital Picture Exchange format). The Cineon file format traces it's roots back to one of the earliest "film as digital" devices, the Kodak Cineon. The Kodak Cineon, introduced in 1992, was a scanner that took film images and translated them into digital data. Today many devices from a number of manufacturers perform such a process.

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Since files bearing the .cin extension were always related to film, they tend to always be in Log RGB. Log RGB is a color scheme designed to approximate the characteristics of film emulsion in a digital environment. An easy analogy is this: Log RGB is like a "digital film negative" while linear RGB (usually just referred to as RGB) is like a "digital film positive." To transform a log RGB image into a "positive", Look Up Tables (LUTs) can be applied to the image so that this raw image can be seen as it would be in its finished form.

As already mentioned, Cineon files are not the only file format that can be used to house the 2K data. DPX (Digital Picture Exchange) is quickly becoming the standard since being defined by SMPTE. Like files bearing the .cin extension, files bearing the .dpx extension can be Log RGB, but they can also be linear RGB.

Cineon and DPX files at full size 2048x1556 and 10 bit quality tend to exist as individual frames that occupy 12.2 MB of data. At 12.2 MB/frame, data rates for a second of video climb to roughly 300MB/sec. By comparison, the highest quality HD video images rarely exceed 200MB/sec and most HD formats use only a little over 100MB/sec. Furthermore, most HD material is usually somewhat compressed in order to be recorded onto tape formats; 2K data can achieve an uncompressed status by going straight to a disk array.

If the first major advantage of working with 2K images is their size, then the second advantage of working with digital images at 2K is their handling of color. 2K color data in Log RGB can more closely emulate film properties than video properties. Furthermore, this color information need not be compressed due to the limitations of tape recording, but rather the data can be dealt with as uncompressed when recorded directly to disk.

The Source of 2K Data: Scanning, Telecine and Digital Cameras

Until recently, the only way to acquire a 2K image was to shoot on 35mm film and then scan the original camera negative (OCN). To be fair, most 2K data is still generated in this method since film is still seen as the de facto medium for recording moving images for projection at the highest possible resolution. 2K scanning persisted as the solitary method of creating 2K data until a handful of telecine machines came on the market that could move data at 2K resolution.

Now we are seeing the first generation of what can truly be referred to as "digital cinema" cameras; they lack video recording devices, specifically tape recording capability, in their design and instead concentrate on producing electronic data that aims to emulate, or exceed, the image quality of traditional photochemical film processes.

Transporting 2K Data: HSDL Defined

Moving 2K data is no small task; remember that at 12.2MB/frame, data moves at roughly 300MB/sec. Storage devices, such as RAIDs (Redundant Array of Independent Disks), must have very high bandwidth capabilities to handle recording or playing back the data at full speed. The storage devices must also have adequate space to hold 2K data, as an hour of 2K just exceeds 1 Terabyte.

But storage devices are for storing the data; transporting the data is something different. HSDL (High Speed Data Link) is easiest for video professionals to understand in this way: HSDL is like Dual Link HD for the transmission of 2K data. Where Dual Link HD moves across two SDI cables as video, HSDL moves 2K data over the two SDI cables. Because of the amount of data previously mentioned, full size 2048x1556 images cannot be transmitted over the dual SDI lines at full frame rate. Instead of moving the data at 23.98 (24) frames per second, the HSDL transport stream often adheres to 14.98 frames per second. Because this is transmitted data, not video, the data can be recorded at the 14.98 frames per second rate to a high speed storage device and then played back from this high speed storage device at full speed, typically 23.98 frames per second. In contrast to 2048x1556 images, 2048x1080 digital cinema 2K can move across HSDL at the full frame rate of 23.98 frames per second.

Facilities with two lines of HD-SDI rated cable, in a limited sense, are already prepared for the transmission of 2K data when attached to HSDL devices. If a facility already had storage that could exceed 300MB per second, a facility might also be ready to record and play back 2K data at full frame rate. Again, this transition to a "digital film" environment is far less cumbersome than a 4K digital environment where such numbers more than double those of 2K.

So a third advantage beyond image size and color reproduction is the ability of 2K data to use pre-existing elements of HD infrastructure when adopting 2K. For many facilities, be they large full-service or boutique, this makes the financial transition from HD to 2K less of a burden than a transition to 4K.

The AJA KONA 3: 2K Input/Output Device Opening the Door to Data Centric Workflow and Universal Mastering

The AJA KONA 3 card represents an input/output device (capture card) for facilities considering entering the "film as digital" landscape, because the card is capable of working with SD, HD, Dual Link HD and 2K. The KONA 3 card can receive and send 2K data via HSDL making it compatible with a number of devices such as telecines and digital disk recorders (DDRs) already on the market and working with 2K data.

The advantages of using the KONA 3 as an input/output device extend beyond its 2K HSDL functionality. Not only can users ingest 2K data as simultaneous 2K DPX files and QuickTime files, edit this information, and then output 2K data—users can also elect to ingest 2K data and then output HD from a crop directly derived from the 2K media. An SD downconvert of this HD video can also be simultaneously created, if so desired. For review of 2K data on HD and SD monitors and for some mastering scenarios, the KONA 3 card can be used as a very flexible and effective tool.

Existing 2K data files in the Cineon and DPX file formats can be "wrapped" into 2K QuickTime Reference Movies via AJA's *DPXToQT Translator* application so that users can take advantage of the aforementioned flexibility without writing any new data to their drives. QuickTime reference movies only point back to the source original DPX files from which they are derived. The main advantage of this, beyond not writing any new data to the drives, is that the cumbersome sequence of potentially thousands of frames can be consolidated non-destructively to a single file.

Furthermore, once media exists as a 2K QuickTime movie, it can be converted back into sequential DPX files. Such files can then be given to facilities using software or hardware, such as film recorders, that do not accept QuickTime files. This conversion can be accomplished via the AJA *QTToDPX Translator* application. This process, it should be noted, does require writing new data because it may reflect changes to the images that the user desired to create, such as effects.

AJA Video Systems, Inc. along with other 2K HSDL device manufacturers, has seen the growing need for a high quality image source, like 2K, in an evolving data centric workflow. A 2K source can be used to derive the high quality film, digital cinema, HD and SD deliverables without compromise outside of a cumbersome leap to 4K. 2K capable devices, like the AJA KONA 3 card, will help facilities and filmmakers enter a data-centric workflow that results in a universal mastering environment.

> **Note:** For additional information on 2K and how KONA 3 can help from ingest to output, read the AJA Whitepaper "The KONA 3 2K Process", also available from the AJA website (*http://www.aja.com/pdf/support/ AJA_2K_KONA3_process.pdf*).

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