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# The Encrypted Image

## The Role of Digital Cinema Packages (DCPs) in Audiovisual Archives

As 35mm film technology continues its march towards complete obsolescence, digital projection remains the prevailing method of exhibition for moving images. At the beginning of the 21st century, the impending rollout of digital cinema necessitated the development of a stable and convenient format for theatrical exhibition. The result of this was the Digital Cinema Package (DCP), a grouping of digital elements containing high-resolution image and audio files along with external and embedded metadata. DCPs have since become the global standard for theatrical exhibition, favored by studios, filmmakers and theaters alike. Professional-grade movie theaters are equipped with digital cinema systems, replete with servers and projectors designed specifically to ingest and playback DCPs. The formatting and delivery specifications of DCPs are dictated by the SMPTE ST429-2 Standard as well as the DCI's Digital Cinema Systems Specification (DCSS). Theatrical systems are also set up according to these specifications. However, not all DCPs are necessarily compliant with these standards. Non-compliant DCPs may have issues of playback and interoperability. In recent years, open source software such as DCP-O-Matic has given smaller distributors and filmmakers the ability to create DCPs in-house, averting the high costs of outsourcing to a professional encoding facility. Such DCPs are never assured to be completely DCI-compliant and therefore may not play an all systems. Given that

the Digital Cinema Initiatives was founded by a coalition of major motion picture studios, it can be said that the DCI Specifications generally favor the motion picture industry model. Central to the industry's ethos is the desire to monetize motion picture content to its maximum degree. This entails maintaining rigid control over intellectual property. In the digital age, piracy poses a continual threat to the survival of the entertainment industry. Encryption offers distributors the ability to tightly control and monitor every single viewing of a DCP. While this greatly benefits major motion picture studios, it can cause difficulties for those who operate within different frameworks, such as exhibitors and archives. Since around 2009, DCPs have gradually gained an increased presence in archives. While not officially a preservation format, DCPs offer many advantages for archives. Not only are DCPs convenient for exhibition, they are also rich in metadata which may be very useful for preservation. Due to their complex nature, DCPs require specialized workflows to ensure data integrity and long term stability. Therefore it is essential for archives to fully understand the technical ins and outs of DCPs and stay completely informed regarding DCI Systems Specifications and SMPTE standards.

Over the course of 1980s and 1990's, digital technology gradually began to play an increased role in motion picture production and post-production. The early 2000's saw the introduction of HD Progressive Digital Motion Picture Cameras, beginning in 2000 with the HDW-F900 digital 24p CineAlta Camera, the first professional-grade high-definition camera, developed by Sony and Panavision as result of a project spearheaded by George Lucas. The success of the CineAlta led competitors such as Canon and Panasonic to develop similar products. Over the next few years, major motion picture studios began to embrace entirely digital production workflows. The elimination of film processing fees allowed studios to cut major costs, yet yielded a new set of potential difficulties that came along with managing large

quantities of high-definition digital video. This period also saw the development of digital projection systems, most notably Liquid Crystal Light Valve (developed by JVC) and Digital Light Processing (DLP), developed by Texas Instruments. In 1999, George Lucas, as a part of his mission to champion digital cinema, screened his film Star Wars Episode I: The Phantom Menace, in four locations on both Liquid Crystal Light Valve and DLP projectors, making it the first major motion picture to be theatrically exhibited digitally.[1] Although this represented a major step forward for digital motion picture exhibition, questions still remained as to whether or not these systems were able provide a theatrical viewing experience that was comparable to 35mm projection. In addition, equipping movie theaters world-wide with digital projection systems would be a major challenge. Because of this studios would use *film-out* to print digital motion pictures onto 35mm for theatrical distribution. This remained in practice until around 2013, after which studios began to phase out 35mm distribution entirely. [2]

Another major impediment to the proliferation of digital projection was the lack of an standardization. In 1999, SMPTE formed the Technology Committee on Digital Cinema (DC28), with the goal of defining, designing and standardizing an "overall end-to-end system for theatrical release of motion pictures, replacing the existing 35mm distribution models".[3] The committee was divided into the following study groups: Steerings and Systems, Mastering, Compression, Conditional Access, Transport and Delivery, Audio, Theater Systems and Projection. A status report from January 7, 2001 alludes to the creation of a standard for what is

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[1] Charles S. Swartz, *Understanding Digital Cinema*, 2005, p. 159.
[2] Webster, Andrew. "Paramount Reportedly Abandoning 35mm Film for US Movie Theaters." The Verge, January 18, 2014 https://www.theverge.com/2014/1/18/5321958/paramount-reportedly-abandons-film-for-digital-only-movie-releases.
[3]Rast, R. M. SMPTE's Technology Committee on Digital Cinema, DC28. January 7, 2001.

http://car.france3.mars.free.fr/Formation%20INA%20HD/Colorimetrie%20HD/STAGE_HD%20(E)/Smpte/DC28_1.pdf

termed a DCDM (Digital Cinema Distribution Master). The proposed specifications included color space, bit depth, pixel format, frame rate, transport protocol, and the physical interface to the projector. In 2002, seven major motion picture studios (Metro Goldwyn-Mayer, Paramount, Sony, 20th Century Fox, Universal and Warner Bros) jointly formed Digital Cinema Initiatives, LLC (DCI). The goal of the organization was to establish a standardized, open architecture for digital cinema, in order to ensure "a uniform and high level of technical performance, reliability and quality".[4] The first version of the DCI Systems Specifications (V1.0) was published in 2005. Drawing from both SMPTE and ISO standards, DCI outlined specifications for Digital Cinema Packages (DCPs), including their file type, structure and system requirements. DCI also took into consideration growing concerns of the motion picture industry surrounding piracy. The rise of digital cinema and the advent of the internet had resulted in a major influx of piracy. Optical media formats such as VCD and DVD allowed pirates to produce exact copies of their contents en masse without any loss in resolution.[5] Motion picture studios were very aware of the threat posed by piracy, and as a result the DCI specifications were constructed in order to ensure robust protection of intellectual property by way of encryption. The DCI specifications have been addended many times since its publishing in 2005, yet it remains the industry standard for digital theatrical distribution.

The proliferation of DCPs and the rollout of digital cinema began before SMPTE had sufficient time to develop a reliable standard. During this early period, the InterOP DCP was created as a place-holder; to function as a de-facto standard in the interim before an official standard was completed. This allowed hardware manufacturers to begin developing tools and

[4] "About DCI." Digital Cinema Initiates, LLC. March 2002. http://www.dcimovies.com/
[5] Holly Willis, New Digital Cinema: Reinventing the Moving Image (London: Wallflower, 2006), 6

equipment for digital projection.[6] By the time SMPTE DCP standard was finally published in 2009, many InterOP systems were already in place. Although all SMPTE based systems are backwards-compatible, certain features of SMPTE DCPs (mainly having to do with encryption and subtitles) prevent them from being playable on InterOP systems. Because of this issue, distributors will often create both an InterOP and SMPTE DCP in order to ensure compatibility across all systems. Although never formally published, InterOP remains a widely used unofficial standard. In this respect, the InterOP DCP has long out-lived its intended lifespan.

Digital Cinema Packages consists of 6-7 components: Asset Map, Volume Index, Packing List (PKL), Composition Play List (CPL), one or more .mxf, Image Track Files, one or more Audio Track Files, and in some cases, one or more Subtitle Track files. The Image Track files are made up of sequentially numbered JPEG 2000 compressed files contained in an .mxf wrapper. In order to be compliant with DCI specifications, the image file must be formatted according to the following specs: Resolution must be either 2K (2048x1080) or 4K (4096x2160). If the file is in 2K resolution, it can be projected at either 24 frame/s or 48 frame/s. For 4K files, only 24 fps is permitted. The images must also be formatted for DCI-approved XYZ Color Space. Specifications do not allow for a bit rate which exceeds 250 MBps, making lossy compression necessary for DCI-Compliant DCPs. All Audio Track Files must be 24 bit, linear PCM uncompressed multichannel Broadcast WAV files, either 48kZ or 96Hz. DCI-Compliant DCPs may contain up to 16 audio tracks. The other components are XML documents which carry valuable metadata pertaining to the structure and contents of the DCP. Both the Asset Map and the VolumeIndex serve to identify the files contained within the DCP and describe their location within the file system. Each file is assigned a Unique Identifier (UUID), which are used

[6]"What Is the Difference Between “Interop” and “SMPTE” DCPs?" DCP Master. https://thedcpmaster.com/interop-vs-smpte-dcp/

in the Asset Map and VolumeIndex to map files to their location. The Packing List (PKL) provides a complete list all of the elements within the DCP as well as metadata for each element including: date of creation, software used to create it, and hash value. Hash values are used by the server before playback to ensure the files within a DCP have not been changed or tampered with. A Composition Playlist (CPL) describes the playback sequence of the files; functioning as a timeline for the DCP. The CPL document defines how the audio, image and in some cases subtitle files will sync up with one another. Subtitles are typically in the form of .xml files, yet may also exist as losslessly compressed PNG files which are to be overlaid on top of the image displayed on screen at specific times during playback.[7] The InterOP and SMPTE DCP standards are different in terms of how the .xml documents are structured and how the binary data of the .mxf files are organized.[8] Therefore it essential to unwrap and re-wrap the Image and Audio Track files when converted a DCP from InterOP to SMPTE. Another expanded feature of the SMPTE is the use of CPL markers for theatre automation. Markers are embedded into a SMPTE CPL to mark specific frames. For example, CPL markers may signify the beginning and end of title credits, intermission and end credits.[9]

Encryption is one of the major features of DCPs and provides a high level of security for filmmakers and distributors. However, encryption can also be a major source of difficulty for archives and distributors, functioning as an obstacle to the preservation and access of the material. The content of the DCP is encrypted using the Advanced Encryption Standard (AES).

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[7] Peltzman, Shira. Unlocking the DCP: Evaluating the Risks, Preservation and Long-Term Management of Digital Cinema Packages in Audiovisual Archives. Master's thesis, New York University Tisch School of the Arts, 2013. https://www.nyu.edu/tisch/preservation/program/student_work/2013spring/ShiraPeltzman_MIAPThesis_FinalDraft_Revised_October2013.pdf

[8] Whittlesey, Jim. Digital Cinema Content Distribution: Understanding Interop and SMPTE Digital Cinema Package (DCP) Youtube Video, 44:53, January 25, 2017 https://www.youtube.com/watch?v=4yWyBrLtKOo&t=733s

[9] Witham, Chris, and Nick Mitchell. "SMPTE DCP Implementation." January 2016. https://www.smpte.org/sites/default/files/2016-04-06-ST-DCP-Mitchel-Witham-V4-Handout-2.pdf.

AES encryption generates a 128-character number which is attached to the data. This number is referred to as the *plaintext*. The plaintext is then run through an algorithm which scrambles the original number. This output is known as *ciphertext.* AES employs a symmetric cipher, meaning the original number (plaintext) functions as a key to unscramble the cipher text in order to decrypt the data.[10] For greater security, the AES keys are themselves encrypted using RSA encryption. Unlike AES, RSA employs an asymmetric cipher, meaning a new key must be generated for every use. This gives distributors complete control when and where the DCP is viewed. Anytime an encrypted DCP is to be shown, a unique key must be created. The key is designed to recognize the specific server and projector the DCP is being played on, using these device's Digital Signature (a number containing the device's serial number), which is provided to the distributor at some point before the screening. The key is delivered in the form of an small XML file known as a KDM (Key Delivery Method), which may be emailed to the exhibitor or delivered on a USB stick. The KDM is designed to unlock the DCP for a prescribed window of time, typically allocated according to the arranged screening times. These time "engagements" may vary from as long as weeks to the exact duration of the screening, leaving little room for the projectionist or exhibitor to view the contents of the DCP before showtime.[11]

DCP creation can be broken down into three stages: the first stage involves what the DCI Systems Specifications refer to as the Digital Source Master (DSM). The Digital Source Master is a loose term use to refer to the original audiovisual elements use to create the DCP. The next stage involves transcoding, compressing/uncompressing, and restructuring the files in order to create a Digital Cinema Distribution Master (DCDM). The images files must be converted to TIFF Revision 6.0 files with JPEG 2000 compression. The image must also be up-resed, down-

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[10] Shira Peltzman, 22

[11] "Technology FAQs." Cinepedia. August 12, 2018. https://cinepedia.com/faqs/technology-faqs/.

resed, sped up or slowed down in order to be compliant with DCI-specified resolutions and frame rates. The same is true for the audio track, which must be converted into a 24 bit Broadcast Wave File. The color space must be re-mapped from RGB (optimal for LCD computer screens) to XYZ (optimal for projection).[12] Once these files are fully standardized, the DCDM is used to create the final DCP. However, the majority of DCPs are created using a software which automates the entire process. Therefore, the DCDM is only virtually produced. Meaning, once the software has outputted the DCP, the DCDM no longer exists and cannot be preserved.

Larger motion picture studios and distributors will typically out-source to digital cinema encoding facilities to produce their DCPs. Professionally encoded DCPs are ensured to be completely DCI-compliant and will play on all systems. This may cost up to $1000-3000 depending on the length of the motion picture.[13] Smaller distributors or filmmakers may choose to create their own DCPs in-house, using either proprietary or open-source software. Generally speaking, proprietary software is more reliable and DCI-compliant, yet depending on the needs of the creator, open-source software may be perfectly suitable given the circumstance. If a DCP must play on multiple systems, it is more necessary to be fully DCI-compliant, however Commonly used proprietary options for DCP creation include: Dolby/Doremi CineAsset (also used for playback), easyDCP and QubeMaster Pro. Open source software options include: DCP-O-Matic, Open DCP, and DCP Builder.[14]

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[12] Wikipedia contributors, "List of color spaces and their uses," Wikipedia, The Free Encyclopedia, https://en.wikipedia.org/w/index.php?title=List_of_color_spaces_and_their_uses&oldid=847070964 (accessed December 15, 2018).

[13] Elbert, J. E. "DCP Info: Everything You Ever Wanted to Know (and More) about D-Cinema and Digital Cinema Packages." 2016. http://www.hbfilmworks.com/dcp-info.html.

[14] Wikipedia contributors, "Digital Cinema Package," Wikipedia, The Free Encyclopedia, https://en.wikipedia.org/w/index.php?title=Digital_Cinema_Package&oldid=870385357 (accessed December 15, 2018).

It is possible to digitally deliver DCPs, however due to their large size, it is recommended that they be delivered on physical hard drives. The industry choice for DCP delivery are DX115 drives, often simply referred to at "CRU Drives" after their largest manufacturer. CRU drive (also called CRUData Ports) are not drives in themselves; they are hard drive cases which are designed to easily connect to digital cinema servers.[15] CRU Drives use a SATA input which allows for high-speed data transfer. Certain hard drives may be removed from their original case and rehoused inside of a CRU drive. DCI does not include drive formatting requirements, however it is important that the drive be formatted to fit the same computing environment as the server, or else it will not be mounted. Linux is the industry standard for both DCP creation and digital cinema servers. All professionally encoded DCPs are formatted in a Linux environment and will play on the majority of digital server systems. The ISDCF recommends the EXT-3 file system for data storage. However, it is more common for smaller distribution filmmakers to use Mac environments as well as hard drives with Mac file systems. If an archive or exhibitor receives a DCP on a hard drive with an incorrect file system, the DCP can be copied (using drag-and-drop) onto a properly formatted drive.[16] Digital cinema servers have a user-friendly graphical user interface which allows for automated ingest. An ingest time will vary depending on the size and duration of the DCP. During ingest the server will check for errors using the hash value that was calculated during the DCPs creation. After the DCP has been ingested, the exhibitor can create a Show Playlist, which includes all of appropriate elements required for a screening including trailers, subtitles, advertisements.[17] If a DCP is encrypted the exhibitor must copy the contents of the KDM into the server before ingest occurs.

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[15] "What Is a CRU Drive, Exhibition Kit, or DX115 Drive?" DCP Master. https://thedcpmaster.com/cru-dx115-exhibition-kit/.
[16] Evelyn Emile, "Conversation with Evelyn Emile, Projectionist at Anthology Film Archives" December 7th, 2018
[17] Shira Peltzman, 21

Although metadata is contained within the auxiliary elements of a DCP such as the PKL, exhibitors will often rely exclusively on the file name to understand the contents of the DCP. [18]This is due to the fact that encrypted DCPs cannot be viewed before showtime. Because of this, it is essential that DCP files follow standardized file naming conventions. The current file naming standard was created by the Inter-Society Digital Cinema Forum (ISDCF), which is an open discussion forum made up of individuals involved in digital cinema. The file name must include the following information: Film title, Content Type (e.g feature, trailer or promo etc) Content Type Modifier(e.g 2D, 3D) Projector Aspect Ratio, Language, Territory and Rating, Audio Type, Resolution, Studio, Date, Facility, Standard and Package Type. The ISCDF website clarifies that the naming convention is designed to create human readable content and should not be depended upon for automation, stating "Systems shall not reject content based on real or perceived errors in the use of the naming convention".[19]

For archives who do not have a digital cinema server on hand, there are a few options for DCP playback, although support is very limited . This is in part because of the performance-demanding nature of encoding JPEG 2000 files.[20] Among these options AS-DCPLIB, permissive free file access library which can be used for DCP playback. There are also a few ffmpeg commands which can be used to enable playback. The command: ffmpeg -*i input_video_file*.mxf -*input_audio_file*.mxf -c:v libx264 - pix_fmt yuv420 -c:a aac *output_file.mp4* will transcode the MXF-wrapped files into H.264 Video files. This command only works for unencrypted, single-

[18] Evelyn Emile "Conversation"
[19] "Digital Cinema Naming Convention." Inter-Society Digital Cinema Forum. January 2018. http://isdcf.com/dcnc/.
[20]"Support DCP Playback." FFmpeg Forums. February 15, 2017. https://trac.ffmpeg.org/ticket/6166.

reel DCPs.[21] There are on going efforts among the VLC community to develop features will allow for user-friendly DCP playback using VLC player.[22]

It is important that archives' have a thorough system in place for ensuring data integrity for DCPs. A DCP may arrive without proper filenames or incorrect metadata. Files may also be corrupted or affected at some point during delivery process. Smaller distributors and filmmakers may not check or have the tools to playback their own DCP before sending. Often this will result in errors in bit-depth, or a lack of synchronization between image and audio.[23] The onus does not fall upon the archive to fix these problems, simply to detect them and if necessary, request a corrected version of the DCP.[24] Many of these errors cannot be detected by viewing and require more thorough inspection. One available tool is Clairmeta, a python package designed for DCP probing and checking.[25] Among its features include DCP Probe, a metadata extraction of the whole DCP, including all XML fields and MXF assets. The DCP Checker performs many functions including validation of SMPTE/Interop standard convention, data integrity (MIME type, size and checksum validation), foreign file identification, XSD schema validation, Digital Signature validation, Intra/InterReels integrity and coherence, metadata match between CPL assets and MXF headers, as well as picture tests, sound tests and deep inspection of Interop and SMPTE subtitles. dcp_inspect is another tool for inspection and validation of DCPs. Dcp_inspect is included in a package of open source tools along with an installer script called the Digital Cinema Tools. This repository includes: asdcapib, dcp_inspect, kdm_decrypt.rb (will decrypt Interop and SMPTE KDMs provided there is access to a targeted key),

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[21] "H.264 to DCP." Amia Open Source. https://amiaopensource.github.io/ffmprovisr/index.html#dcp_to_h264.
[22] "Port Asdcplib to Nettle." VLC Bug Tracker. May 2016. https://trac.videolan.org/vlc/.
[23] Shira Peltzman, 68
[24] Caroline Gil "Conversation with Caroline Gil: Media Conservator at Museum of Modern Art" December 7th, 2018
[25] "Clairmeta." GitHub. 2018. https://github.com/Ymagis/ClairMeta.

db_adjust_for_dolby_fader_ref.rb(helps figure out the required level change when targeting a specific Dolby system) xsd_check.rb (a stand-alone tool to check Assetmats, PKLs CPLs and KDMs, dc_crypto_contex.rb (directly of certificates) signature_check.rb, x509_extract.rb and public_key_thumbprint, which will generate the thumbing of the public key embedded in a X.509 certificate. Archival workflows for DCPs vary depending on the institution. Many archives perform data integrity checks at the point of acquisition/ingest, but do not conduct regular checks as part of their workflow. [26]

The presence of DCPs in the archive is a relatively recent phenomenon; increasing gradually over the last 10-15 years. Although DCPs are considered an exhibition rather than a preservation format, they offer a plethora of unique benefits for the archive. DCPs are not only convenient for access, they also carry information concerning the motion pictures exhibition that may be valuable to the archive. Different institutions have varying approaches to the acquisition and preservation of DCPs. Major archives usually have a set of guidelines specifying the types of formats and versions that are acceptable for submission, known as 'preferred elements'.[27] Ideally archives will acquire a preservation master as well as a DCP. The complexities of DCPs make them inconvenient for certain purposes, which is why it is beneficial to keep a more simplified version of the material. The guidelines for submission are dictated by the mission of the institution. Fine art museums are more likely to value originality and therefore may prefer the Digital Source Master (DSM), since it is as close as possible to the original master. Other institutions may be less interested in these concerns and be more focused preserving the material in the form it was exhibited. The metadata contained in CPLs and PKLs offers valuable insight into how a movies exhibition history . Well-funded institutions with more robust digital

[26] Caroline Gil, "Conversation with Caroline Gil"
[27] Shira Peltzman, 37

repositories may be more inclined to accept multiple variations of a digital file. Smaller scale archives may opt to store material in only one form and not keep a DCP in addition to a digital master file out budgetary and storage concerns. As with any other kind of digital material, it is important for the material to be copied and stored on two or more separate storage systems, preferably in more than one geographical location to ensure long-term preservation. Both the OAIS Reference Model and NSDA Levels of Preservation are valuable guides to refer to when setting up a digital repository and developing a workflow for digital preservation.[28] [29]

One major impediment to the preservation of DCPs is encryption. Encryption leaves very little wiggle-room for archives to preserve and access material. Many archivists have concluded that attempting to preserve encrypted DCPs is a pointless venture, given the amount of complications that they carry. If a key is lost or is no longer functional, there is no way to bypass the KDM or unencrypt the DCP and hacking is virtually impossible. This is due to the sophistication of the dual AES and RSA encryption. A pamphlet issued by the Digital Serving and Distribution Arm boasts that STMPTE DCP encryption is "equivalent to that used by the Bank England.. so if you can hack a DCP you may as well hack the bank".[30] This is why it has become increasingly common for archives to refuse encrypted DCPs entirely. This may pose potential issues for distributors and producers. Although much time has passed since the rollout of digital cinema, paranoia surrounding piracy is still prevalent amongst studios who wish to

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[28] The Open Archival Information System ( OAIS) reference model is "a conceptual framework for an archival system dedicated to preserving and maintaining access to digital information over the long term" Lavoie, Brian. "Research Publications Library 2000 The OAIS Reference Model 166 Meeting the Challenges of Digital Preservation: The OAIS Reference Model." OClC. February 2000. https://www.oclc.org/research/publications/library/2000/lavoie-oais.html.

[29] Phillips, Megan, Jefferson Bailey, Andrea Goethals, and Trevor Owens. "The NDSA Levels of Digital Preservation: An Explanation and Uses." http://www.digitalpreservation.gov/documents/NDSA_Levels_Archiving_2013.pdf.

[30] Deluxe Digital London, "Digital Cinema - Some Descriptions" Digital Servicing & Distribution, Key Delivery Message- DC Clones, Accessed December 5th, 2018 http://www.deluxedigital.co.uk/assets/pdf/DDL_Useful_Descriptions.pdf

monetize moving image content. Because of this, certain parties may be resistant to the idea of providing and archive with an unencrypted DCP, particularly if they retain the intellectual rights to the material. Archivist must be being sensitive to the concerns of filmmakers and studios while also advocating for the preservation of the material. In the event that there pushback towards the idea of creating an unencrypted DCP, it is important for archives to effectively communicate to the issues posed by encryption.

As digital technology continues to progress, so will the packaging and exhibition of digital cinema. New developments will result in changing standards and formatting specifications. It is important that archives account for these changes in their workflow and ensure backwards compatibility. This entails regularly migrating, upgrading and transcoding DCPs to fit current specifications. In order to do this it is necessary to be completely up to date on developments related to DCP creation and exhibition. The Inter-Society Digital Cinema Forum offers valuable insight into the conversations surrounding DCP standardization. The ISDCF is comprised of individuals all areas of the field, including studios, equipment manufactures and consultants.[31] For archivists, participation in these discussions gives the opportunity to contribute an archivist's perspective to the general discussion. Given ISDCFs influence the industry, having more of an archivist presence in the forum may lead to the development of more archivist-friendly tools and standards for DCP creation. Other valuable platforms for discussion include GitHub and the Association of Moving Image Archivists (AMIA) Conference and List-Serv. One of the panels offered at the most recent AMIA Conference, titled "War Stories from the Front Lines of Digital Cinema" discussed best practices

[31] "Inter-Society Digital Cinema Forum." http://isdcf.com/ISDCF/home/welcome.html.

for creating DCPs in-house.[32] There was also a round-table discussion entitled "DCP Encryption & Archiving Encrypted DCPs" as well as a workshop demonstrating DCP-O-Matic.[33] These discussions are indicative of an ever growing need in the archival community to establish best practices and strategies for dealing DCP and KDMs in an archival environment. Open source tools such as VLC and ffmpeg are subject to constant additions offer great potential for digital archivists. Github gives archivists a platform to petition for changes in open source software dependent on their needs. Although improvements have been made in recent years, there is still no software which can sufficiently offer full scale support for JPEG 2000 in all its complexity. Developing a user-friendly open source tool that could sufficiently handle JPEG 2000 would greatly facilitate digital preservation workflows for DCPs.

[32] This panel featured Rebecca Hall, Andy Uhrich, Doug McLaren and Wade Hannibal and took place November, 30 2018 "Conference Program." Association of Moving Image Archiving Conference. http://www.amiaconference.net/preliminary-program-3/.

[33] "Friday in the PAVilion: Sharing Knowledge." Association of Moving Image Archiving Conference. http://www.amiaconference.net/pavilion-peer-to-peer/.