

Introduction

This document will set forth a standards recommendation for moving images and digital video. In particular, this video object standard will recommend specific file formats for the preservation master and derivatives, for implementation into the Rutgers Community Repository (RUcore) and projects using similar architectures, as well as recommend sampling rates and specifications for presentation derivatives.

As with all other standard types established thus far, it will be mandatory to store and preserve an archival master, to ensure an object of the highest available quality is maintained for digital preservation. Additionally, one or more downsampled and compressed presentations copies will be made available for end users wishing to access these objects online. These presentation copies are to be stored and accessible in formats that users will find easy to play back, and will use file formats and codecs that are compatible with multiple computer platforms, using established industry standards.

Accepted File Formats for Preservation

In order of preference:

- **Uncompressed, Full Frame Video (.AVI file format)**
- **Apple ProRes format (.MOV)**
 - Preferred format: ProRes 4444 or 4444XQ
 - Also accepted, in order of preference: ProRes 422HQ, 422, 422LT, 422 Proxy
- **Digital Video Format (.DV, also in .AVI containers at times)**
 - Commonly created by DVCAM and MiniDV video cameras
- **Born digital MPEG-2 and MPEG-4 AVC Multiplexed Transport Streams (.mp4, .mts, .m2ts, .mov, .mpeg, .mpg, .ts, .tsv, .tsa)**
 - Commonly created by HD and SD digital camcorders, solid state digital video cameras, smartphones and tablets
- **REDCODE RAW Codec, RED Digital magazine, RED Digital Clip (.mov, .r3d, .rdc, .rdm, .rsx)**
 - A native digital format of industry-common RED digital cinema cameras, typically consisting of a series of JPEG2000 compressed images, multiplexed with audio.

Also supported:

- **Digital files created by digital video editing suites (e.g. Adobe Premiere Pro, Final Cut Pro)**
 - All files generated or included in a digital video project from video editing software should be considered for preservation.
- **Matroska Multimedia Container (.mkv, mk3d, .mka, .mks)**
 - An open standard free container format, designed to hold an unlimited number of video, audio, picture, or subtitle tracks in one file.
 - Careful analysis and documentation of the contents of a Matroska container should be obtained.

Recommended video specifications for preservation

- **For Motion Picture Film:** *Minimum DCI Compliant 4K Resolution, same framerate as original.*
Multiple resolution specifications exist for Digital Cinema Initiatives 4K and 8K resolution. A good starting point for exploring all options are the Wikipedia articles on 4K and 8K resolutions. See:

http://en.wikipedia.org/wiki/4K_resolution

and

http://en.wikipedia.org/wiki/8K_resolution

Ultimately, decisions on specific resolutions and formats will likely require consultations with the collection owner, and the Digital Curator.

- **For analog Standard Definition (SD) video, NTSC:** *29.97 frames per second, 640 x 480 resolution (assuming square pixels), 4:2:2 quantization, 25MiB/s data rate.*
We recognize this sampling scheme as the best practical standard to ensure a good preservation master of analog SD video archives, and will be the most common digitization sampling rate for objects that come to us as SD analog video. This standard is based on our experiences with digitizing videotaped objects.
- **For Digital objects (i.e. DV/HDV), including high definition video:**
When capturing new content, use the highest level resolution and bitrates permitted by the hardware used.

For born-digital video objects such as DV, native broadcast MPEG-4 or MPEG-2, the logical course of action is to preserve the exact specifications of the original. It will not be wise to downsample the original as that will cause a loss of object data, and no improvement in quality will be gained from upsampling.

Presentation video files:

- **At least one streaming/progressive downloadable video clip:**
 - **MPEG-4 H.264 video (.MOV, .M4V, .MP4), encoded for hinted streaming**
 - For 4:3 – Minimum of **640 x 480 resolution (square pixels), 30 frames per second, multi-pass encoding,, using “Baseline” or “Main” encoding profiles, level 3.0 or lower.**
 - **For 16:9 HD – Two Streams:**
 - One Downsampled Standard Definition stream: **720 x 480 resolution (square pixels), 30 frames per second, multi-pass encoding, using “Baseline” or “Main” encoding profiles, level 3.0 or lower.**
 - One High Definition Stream: minimum **1280 x 720 resolution (square pixels), 30 frames per second, multi-pass encoding, using “Baseline” or “Main” encoding profiles, level 3.2 or higher.**
 - Variable bit rate, minimum data rate of **860kbps, with preferred rates up to 2.5 Mbps.**
Use higher bitrates for videos with more detail and greater motion.
 - **Key frames inserted every 72 frames at minimum, or auto-select. This rate should be adjusted when necessary for best results.**

This recommendation is aimed at balancing the file size, and the amount of bandwidth required to play the video, while trying not to sacrifice video quality. This specification necessitates the use of a broadband internet connection, but is configured so that most home DSL or casual WiFi users with a minimum 3.0Mbps connection should still be able to view the content.

Background

The handling and preservation of digitized moving images presents a unique challenge to digital repositories. Presently, uncompressed digital video demands an extremely large amount of storage space, and produces incredibly large files. Yet, the need to store an uncompressed or reliable lossless-compressed object is paramount to ensure its longevity.

We also recognize with the growing convergence of digital devices, and the prevalence of smaller video capture equipment, there will be an increasing amount of digital content which is born in a compressed digital format. Such cases will pose long-term preservation challenges depending on the file times, video codecs, resolution and compression levels used. When such video is slated for inclusion into RUCore, a case-by-case condition analysis will occur; best efforts will be made to store the native format as an archival datastream; and when necessary, a converted copy into a designated stable format will also be stored with the archival datastream.

As always, the guidelines presented here are recommendations, and there may be cases where judgment calls will need to be made about objects that would be better preserved by modifying the recommended guidelines for this purpose. In particular, the digitization team has not yet digitized film archives, and as such those formats will need to be analyzed for the best possible digitization settings. The Digital Data Curator, as well as the Digital Preservation Task Force, should be consulted for guidance when such adaptations are required.

Rationale for Presentation formats:

In spite of the present need to store an uncompressed stream when digitizing from an analog master, it is obvious that delivering such an object to end users would be impractical given current average connection speeds. Consequently, there is an additional need for downsampled, compressed presentation formats for video objects, more than any other object type addressed by the repository.

This recommendation is aimed at balancing the file size, and the amount of bandwidth required to play the video, while trying not to sacrifice video quality. This specification necessitates the use of a broadband internet connection, but is configured so that most home DSL or casual WiFi users with a minimum 3.0Mbps connection should still be able to view the content.

MPEG-4 Video, particularly MP4, is cross-platform and can be accessed by desktop computer users of varying operating systems (Windows, Mac, Linux), using free software and established web standards. H.264 video is also viewable on a multitude of internet-connected mobile devices.

Starting in late 2014, the MP4 container format is recommended, as this format permits us to use a single H.264 video file to provide service for mobile devices as well as progressive download and streamed video. Of note is that the “Main” or “Baseline” MP4 encoding profiles for standard definition streams are specified, at version 3.0 or below. This is to ensure streaming compatibility with older mobile devices (e.g. iPhones and iPads manufactured before 2013). For true HD streaming however, higher level profiles are required.