Federal Agencies Digitization Guidelines Initiative

Digital File Formats for Videotape Reformatting

Part 4. Detailed Matrix for Encodings (multi-page)

This document presents the information on multiple, easily printable pages.

Part 3 provides the same information in a unified table to facilitate comparisons.

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The FADGI Audio-Visual Working Group

http://www.digitizationguidelines.gov/audio-visual/

ATTRIBUTES: Sustainability Factors: Disclosure

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Does complete technical documentation exist for this format? Is the format a standard (e.g., ISO)? How stable is the standard? Are source code for associated rendering software, validation tools, and software development kits widely available for this format?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Acceptable** Some documentation is available. Published standards do not exist for these codecs, but documentation is available from multiple sources. Some of the best documentation is brief and available at fourcc.org. Microsoft and Apple also have some documentation available at their websites. SMPTE ST 377 offers some additional information about these encodings.
Uncompressed 4:2:2, 10-bit (v210)	**Good** Not a published standard. It is attributed to both QuickTime and AJA. Apple has some documentation on the structure and ordering of components of this format on their Apple Ice Floe site.
JPEG 2000 - Lossless	**Good** Two sets of disclosure around this format: ISO/IEC 15444-1:2004. Information technology -- JPEG 2000 image coding system -- Part 1: Core coding system (formal name); JPEG 2000 core coding (common name), especially the Broadcast Profiles, and SMPTE ST 422 (although ST 422 is MXF-specific and does not yet specify how to handle interlacing).
ffv1	**Acceptable** Bitstream is fixed and codec is no longer experimental, but documentation remains incomplete. However, there is an organized effort to continue development and documentation of this format. Here is a link to the most recent technical specification: https://github.com/FFmpeg/FFV1/blob/master/ffv1.lyx
MPEG-2 - 4:2:2 Profile/Main Level	**Good** Open published international standard developed by the Moving Picture Experts Group. The specification is available for a fee from ISO (ISO/IEC 13818 and ITU-T Rec. H.222 and H.262). The standard focuses on the encodings and the sequence of bits is well-specified. Also, the source code of the software used to create MPEG-2 is available for a fee.

ATTRIBUTES: Sustainability Factors: Adoption

- Scoring conventions: Wide, Moderate, Low
- Questions to Consider: Is this format likely to become obsolete short, medium, or long-term? How widely adopted is the format in the vendor community? Are there user communities/developer communities that are actively discussing the format and its further development?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Wide** Many cultural heritage institutions use these formats for preservation purposes. Vendors also offer good support for the format. The BBC (UYVY) and the National Archives and Records Administration (YUY2) use 8-bit uncompressed codecs for preservation purposes.
Uncompressed 4:2:2, 10-bit (v210)	**Wide** Many cultural heritage institutions use these formats for preservation purposes. Vendors also offer good support for the format.
JPEG 2000 - Lossless	**Low to Moderate** Some cultural heritage institutions have selected this format for preservation work. Vendors also support it, but sometimes offer their own proprietary flavors instead of the profiles articulated in the standard. The Library of Congress' National Audiovisual Conservation Center (NAVCC) uses JPEG2000 Lossless for preservation purposes.
ffv1	**Low to Moderate** Relatively new format that is beginning to be adopted in the cultural heritage and open-source communities. There are a growing number of software tools that can work with the format- ffmpeg, for example. Most tools that support ffv1 come out of the open-source community, but some vendors are beginning to support it. The City of Vancouver Archives uses ffv1 for preservation purposes.
MPEG-2 - 4:2:2 Profile/Main Level	**Wide** Some cultural heritage institutions use this format for preservation purposes. It is also used throughout the community as an intermediate or mezzanine-level format. In broadcast and vendor communities, the format is widely adopted and well-supported.

ATTRIBUTES: Sustainability Factors: Transparency

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Transparency refers to the degree to which the digital object is open to direct analysis with basic tools.

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Good** Relatively transparent. UYVY and YUY2 are easily understood and identified by open source file analysis and playback tools like MediaInfo and VLC.
Uncompressed 4:2:2, 10-bit (v210)	**Good** Relatively transparent. v210 is easily understood and identified by open source file analysis and playback tools like MediaInfo and VLC.
JPEG 2000 - Lossless	**Acceptable** Depending on the specific flavor of the encoding that is used, this format may or may not be transparent. Proprietary varieties of the format may not be able to be identified and understood by open source file analysis and playback tools like MediaInfo and VLC.
ffv1	**Acceptable** Somewhat transparent format. It can be analyzed using the free tool ffprobe.
MPEG-2 - 4:2:2 Profile/Main Level	**Good** Relatively transparent. MPEG-2 is easily understood and identified by open source file analysis and playback tools like MediaInfo and VLC.

ATTRIBUTES: Sustainability Factors: Self-Documentation

- Scoring conventions: Good, Acceptable Poor
- Questions to Consider: Does the format offer ample documentation (e.g., metadata) that makes the digital object a completely self-describing entity? Does the metadata fully describe the file/file format?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**N/A** The wrapper is typically responsible for providing this capability.
Uncompressed 4:2:2, 10-bit (v210)	**N/A** The wrapper is typically responsible for providing this capability.
JPEG 2000 - Lossless	**Acceptable** High wrapper dependency. Revision of SMPTE ST 422 will provide more clarity around scan type and field order.
ffv1	**Acceptable** High wrapper dependency. Version 3 will be less dependent on the wrapper because it will include information such as display aspect ratio.
MPEG-2 - 4:2:2 Profile/Main Level	**Good** Most critical technical metadata is embedded in the file by default, some additional metadata can be added in non-standardized sections of the stream such as Private and User Data areas. Standardized methods for carrying descriptive data (program title and episode number, for example) are specified as well.

ATTRIBUTES: Sustainability Factors: Native Embedded Metadata Capabilities

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: What embedded metadata standards are available for this format? How mature are the schemas for each? What is the extent of use of the embedded metadata and who is using it?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**N/A** The wrapper is typically responsible for providing this capability.
Uncompressed 4:2:2, 10-bit (v210)	**N/A** The wrapper is typically responsible for providing this capability.
JPEG 2000 - Lossless	**Acceptable** A small set of metadata is required: basic image data (height, width, number of components, bit-depth); color specification (see notes on color maintenance below), and a flag indicating the presence or absence of intellectual property information. This may be supplemented by optional information, e.g., capture or dispay resolution (relating pixel size to physical size) and by data presented in three optional boxes: (1) a box for XML data (specific recommendations regarding XML are provided in Part 2 of the standard and pertain to JPX but may be used in JP2 as well), (2) an IPR box (see technical protection considerations just below), and (3) a UUID box which provides for an object identifier or identifier-references to other digital objects (described by one commentator as providing a generic mechanism for extending the file format to include application-specific data).
ffv1	**Acceptable** Section 4 of the specification indicates that the types of technical metadata required to read and play the file are provided in frame headers. Additional metadata, if any, would be carried by the wrapper format.
MPEG-2 - 4:2:2 Profile/Main Level	**Good** For decoding purposes, identification of the syntax is incorporated throughout the stream. Within the Sequence Header technical metadata such as horizontal/vertical size, pixel aspect ratio, frame rate, bit rate, vbv buffer size, and intra and inter quantizer matrices are provided. While support for technical metadata is fairly comprehensive, support

	for descriptive information is not as complete. Within the ISO/IEC 13818-1 two provisions exist for adding Private (unspecified) Data into the Packetized Elementary Streams (PES). The first is to add the private data into the PES header; the second is to utilize the PES packet data byte field. Private Data is however not coded according to standards specified in the 13818 specification, and its use would therefore be a custom solution possibly not preferable for the purpose of long-term preservation. Private data could include descriptive information about the coding and/or content of the stream. Also, the lack of metadata of the type called bibliographic by librarians motivated the MPEG group to develop MPEG-7, a separately standardized structure for metadata to support discovery and other purposes.

ATTRIBUTES: Sustainability Factors: Impact of Patents

- Scoring conventions: No Impact, Possible Impact
- Questions to Consider: Are there patents related to this format that could have a direct impact on the long-term sustainability of files produced in this format?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**No Impact** None
Uncompressed 4:2:2, 10-bit (v210)	**No Impact** None
JPEG 2000 - Lossless	**No Impact** None (assuming Core Coding, Part 1 of the specification)
ffv1	**No Impact** None
MPEG-2 - 4:2:2 Profile/Main Level	**Possible Impact** Patent rights cover tools used to create MPEG-2 files, not the files themselves. While you may have to pay a license fee in order to purchase and use an MPEG-2 compliant product your files will not be subject to any licensing restrictions.

ATTRIBUTES: Sustainability Factors: Technical Protection Mechanisms

- Scoring conventions: No Impact, Possible Impact
- Questions to Consider: Are there technical protection measures inherent to this format that would prohibit the creation of ample derivatives/other formats?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**No Impact** No documentation that says YUY2 or UYVY have specific encryption capabilities.
Uncompressed 4:2:2, 10-bit (v210)	**No Impact** No documentation that says v210 has specific encryption capabilities.
JPEG 2000 - Lossless	**No Impact** Digital Cinema formats rely heavily on encryption, but most likely this is done by the wrapper.
ffv1	**No Impact** The encoding itself doesn't provide technical protections.
MPEG-2 - 4:2:2 Profile/Main Level	**Possible Impact** Multiple encryption schemes have been developed for MPEG-2. MPEG-2 encryption can be handled by IPMP or Intellectual Property Management and Protection (ISO 13818-11). IPMP is a form of digital rights management and it maintains compatibility among MPEG-2 systems. Other, less wide-spread and completely proprietary encryption systems have been used, these included DigiCipherII and others. Conditional Access Tables are another form of content protection (ISO 13818-1).

ATTRIBUTES: Sustainability Factors: Cost Factors: Implementations costs

- Scoring conventions: High, Medium, Low
- Questions to Consider: How expensive is it to capture, edit, store and move these files?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Low** Well-supported and fairly simple. The costs for implementing these formats are typically low.
Uncompressed 4:2:2, 10-bit (v210)	**Medium** Well-supported, but format does require some additional overhead.
JPEG 2000 - Lossless	**Medium** Well-supported by commercial tools, but somewhat complicated. Format may require additional costs to implement.
ffv1	**Low** Comes out of the open source community and tools that support it are generally free. The costs for implementing this format are typically low.
MPEG-2 - 4:2:2 Profile/Main Level	**Low** Well-supported by both open source and commercial tools. The costs for implementing this format are typically low.

ATTRIBUTES: Sustainability Factors: Cost Factors: Cost of Software

- Scoring conventions: Low (Free, minimum), Medium ($500+), High ($1,000+) Even though you can capture video with software alone, robust hardware makes capturing video faster and better.
- Questions to Consider: How much does capture and editing software cost? Are free tools available?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Low to Medium** VirtualDub is a well-known example of free software that can be used to capture and edit UYVY and YUY2 encodings. Many commercial products can also capture and edit UYVY and YUY2 encodings; these range in cost and platform compatibility.
Uncompressed 4:2:2, 10-bit (v210)	**Medium to High** Most of the tools used to capture to v210 will require a fee. The cost can range from moderately expensive to very pricey.
JPEG 2000 - Lossless	**Medium to High** Tools that capture to JPEG2000 tend to be fairly pricey.
ffv1	**Low** Some open-source and freely available tools have been created to capture to ffv1.
MPEG-2 - 4:2:2 Profile/Main Level	**Medium** Most of the tools used to capture to MPEG-2 will require a fee. The cost is usually moderate.

ATTRIBUTES: Sustainability Factors: Cost Factors: Cost of Hardware

Scoring conventions: Low ($1,000), Medium ($1,000+), High ($10,000+). Even though you can capture video with cheap hardware, more robust hardware makes capturing/editing faster and better.

- Questions to Consider: How much does capture and editing hardware cost? Are low-cost tools sufficient?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Low to Medium** It is possible to capture to these formats with fairly cheap, generic hardware. However if you buy dedicated hardware, i.e. an encoding card, the performance and throughput of your digitization system will be significantly better.
Uncompressed 4:2:2, 10-bit (v210)	**Medium to High** Most likely, you will need a dedicated hardware, i.e. an encoding card, to achieve adequate performance when capturing to this format.
JPEG 2000 - Lossless	**Medium to High** Most likely, you will need a dedicated hardware, i.e. an encoding card, to achieve adequate performance when capturing to this format.
ffv1	**Low to Medium** It is possible to capture to this formats with generic hardware. However if you use a more robust workstation, the performance and throughput of your digitization system will be significantly better.
MPEG-2 - 4:2:2 Profile/Main Level	**Medium** Most of the tools used to capture to MPEG-2 will require a fee. The cost is usually moderate.

ATTRIBUTES: Sustainability Factors: Cost Factors: Storage Cost

- Scoring conventions: High= More than 1 GB per minute, Medium= 1 GB per minute, Low= Less than 1 GB per minute
- For additional frame of reference:
    - 1 hour of uncompressed 10-bit = 94 GB
    - 1 hour of uncompressed 8-bit =72 GB
    - 1 hour of J2K = 52.83 GB
    - 1 hour of MPEG-2 @ 50Mbps = 23 GB
- Questions to Consider: Are files created in this format usually large, medium, or small in size?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**High** These files are large and uncompressed; they will require significant storage resources.
Uncompressed 4:2:2, 10-bit (v210)	**High** These files are large and uncompressed; they will require significant storage resources. Additionally, v210 is one of the few codecs that actually adds padding bits; it adds 2 bits of padding for every 3 10-bit samples. Because of this 10-bit in v210 takes 33% more storage space than raw 8-bit, even more than the presumed 20% increase from 8 to 10-bits.
JPEG 2000 - Lossless	**Medium** These files are losslessly compressed so they will require slightly less storage.
ffv1	**Medium** These files are losslessly compressed so they will require slightly less storage.
MPEG-2 - 4:2:2 Profile/Main Level	**Low** These files use lossy compression and will take up significantly less space than uncompressed or lossless compression.

ATTRIBUTES: Sustainability Factors: Cost Factors: Network Cost

- Scoring conventions: High= More than real-time, Medium= Real-time, Low= Less than real-time. These costs may be more sensitive to scale of throughput than to size of the files. We are assuming an average network infrastructure, probably GigE with close to 1Gbps throughput.
- Questions to Consider: Does the transfer of files in this format effect performance of internal networks to the point where it would cost more to implement this format? We are assuming an average network infrastructure, probably GigE with close to 1Gbps throughput.

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**High** These files are large and may slowdown or overwhelm internal networks.
Uncompressed 4:2:2, 10-bit (v210)	**High** These files are large and may slowdown or overwhelm internal networks.
JPEG 2000 - Lossless	**Medium** These files use lossless compression and will probably transfer in about real-time.
ffv1	**Medium** These files use lossless compression and will probably transfer in about real-time.
MPEG-2 - 4:2:2 Profile/Main Level	**Low** These files use lossy compression and will probably transfer at rates faster than real-time.

ATTRIBUTES: System Implementation Factors: Level of difficulty/complexity to implement

- Scoring conventions: High, Medium, Low
- Questions to Consider: Given all of the system implementation factors, how hard is it to implement this format? What is the level of effort associated with the implementation of this format? Are there special requirements for this format that would change the nominal workflow for digitization/information life cycle?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Low** Fairly easy to implement. Both commercial and open source tools offer consistent support for a variety of tasks including playback, metadata manipulation and transcoding.
Uncompressed 4:2:2, 10-bit (v210)	**Low** Fairly easy to implement. Both commercial and open source tools offer consistent support for a variety of tasks including playback, metadata manipulation and transcoding.
JPEG 2000 - Lossless	**Medium** Lingering issues with interoperability and a range of proprietary implementations of this format are problematic. Commercial tools will probably be required and may support only limited flavors of the format.
ffv1	**Medium** Well-supported and understood in the open source community. The cultural heritage community is gaining familiarity with the format and commercial vendors are beginning to release tools to support it.
MPEG-2 - 4:2:2 Profile/Main Level	**Low** Many tools support the MPEG-2 encoding. More advanced features will require the use of commercial tools.

ATTRIBUTES: System Implementation Factors: Technical Complexity

- Scoring conventions: High, Medium, Low
- Questions to Consider: Are the tools command-line meant for engineers or GUI-centered applications accessible to the average user?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Low** Tools are well-developed and typically run from a GUI.
Uncompressed 4:2:2, 10-bit (v210)	**Low** Tools are well-developed and typically run from a GUI.
JPEG 2000 - Lossless	**Medium** Format is somewhat complex and will require specialized tools. Familiarity with the format will be required to successfully implement it.
ffv1	**Medium** Tools tend to require technical expertise. They sometimes run from a command-line instead of a GUI and may require less common platforms such as Linux.
MPEG-2 - 4:2:2 Profile/Main Level	**Low** Familiarity with this format will facilitate successful implementation. Tools that support this format are well-developed and typically run from a GUI.

ATTRIBUTES: System Implementation Factors: Availability of Tools for: Rendering/playback and Editing

- Scoring conventions: Wide availability, Moderate availability, Limited availability
- Questions to Consider: Are there tools available for this format? What is the mix of open source and commercial tools?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Wide Availability** Good support from open source tools including VLC. Commercial tools usually support this format as well.
Uncompressed 4:2:2, 10-bit (v210)	**Wide Availability** Good support from open source tools including VLC. Commercial tools usually support this format as well.
JPEG 2000 - Lossless	**Moderate Availability** Some tools are available, but support varies due to lingering issues with interoperability. The majority of tools available for this format are commercial, not open source.
ffv1	**Moderate Availability** Good support from open source tools including ffplay. Most commercial tools do not currently support the ffv1 codec.
MPEG-2 - 4:2:2 Profile/Main Level	**Wide Availability** Good support from open source tools including VLC.

ATTRIBUTES: System Implementation Factors: Availability of Tools for: Metadata extraction and Metadata embedding

- Scoring conventions: Wide availability, Moderate availability, Limited availability
- Questions to Consider: Are there tools available for this format? What is the mix of open source and commercial tools? What level of effort is necessary in order to extract or embed metadata?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Wide Availability** Good support for metadata extraction from open source tools including MediaInfo. Support for metadata embedding depends on the wrapper in use.
Uncompressed 4:2:2, 10-bit (v210)	**Wide Availability** Good support for metadata extraction from open source tools including MediaInfo. Support for metadata embedding depends on the wrapper in use.
JPEG 2000 - Lossless	**Moderate Availability** Some tools are available, but support varies due to lingering issues with interoperability. The majority of tools available for this format are commercial, not open source.
ffv1	**Moderate Availability** Good support for metadata embedding and extraction from open source tools including ffmpeg. Most commercial tools do not currently support the ffv1 codec.
MPEG-2 - 4:2:2 Profile/Main Level	**Wide Availability** Good support for metadata extraction from open source tools including MediaInfo. Support for metadata embedding will probably require commercial tools.

ATTRIBUTES: System Implementation Factors: Availability of Tools for: Transcoding

- Scoring conventions: Wide availability, Moderate availability, Limited availability
- Questions to Consider: Are there tools available for this format? What is the mix of open source and commercial tools? What level of effort is necessary in order to transcode?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Wide Availability** Relatively easy to create derivatives and new preservation formats. A good mix of open source and commercial tools support can transcode from this format. ffmpeg is an example of a free tool that can perform these transcodes.
Uncompressed 4:2:2, 10-bit (v210)	**Wide Availability** Relatively easy to create derivatives and new preservation formats. A good mix of open source and commercial tools support transcodes from this format. ffmpeg is an example of a free tool that can perform these transcodes.
JPEG 2000 - Lossless	**Moderate Availability** Some tools are available, but support varies due to lingering issues with interoperability. The majority of tools available for this format are commercial, not open source.
ffv1	**Moderate Availability** Open source tool like ffmpeg could easily create derivatives and new preservation formats if there is the technical knowledge and experience to use the command line interface. Commercial tools are also beginning to support ffv1.
MPEG-2 - 4:2:2 Profile/Main Level	**Wide Availability** Relatively easy to create derivatives and new preservation formats. A good mix of open source and commercial tools support transcodes from this format. ffmpeg is an example of an open source tool that can perform these transcodes.

ATTRIBUTES: System Implementation Factors: Availability of Tools to: Measure Compliance with Institutional Specifications

- Scoring conventions: Wide availability, Moderate availability, Limited availability
- Questions to Consider: How easy is it to ensure that you are producing a file that conforms to your institutional specifications?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Wide Availability** Open source tools like MediaInfo and AVI MetaEdit can extract technical metadata which can be compared against institutional specs. Commercial tools can also do this work.
Uncompressed 4:2:2, 10-bit (v210)	**Wide Availability** Open-source tools like MediaInfo can extract technical metadata which can be compared against institutional specs. Commercial tools can also do this work.
JPEG 2000 - Lossless	**Wide Availability** Open-source tools like MediaInfo can extract technical metadata which can be compared against institutional specs. Commercial tools can also do this work.
ffv1	**Wide Availability** Open source tools like MediaInfo and ffprobe can extract technical metadata which can be compared against institutional specs. Commercial tools can also do this work.
MPEG-2 - 4:2:2 Profile/Main Level	**Wide Availability** Open-source tools like MediaInfo can extract technical metadata which can be compared against institutional specs. Commercial tools can also do this work.

ATTRIBUTES: System Implementation Factors: Availability Tools to:

Tools to Evaluate and Monitor Content Quality

- Scoring conventions: Wide availability, Moderate availability, Limited availability
- Questions to Consider: How easy is it to ensure that you are producing a file that conforms to broadcast specifications or other quality measures?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Moderate Availability** Open source tools like MediaInfo could be used to ensure correct file characteristics. In order to evaluate the quality of the video content, commercial tools will probably be required. Also of note, Bay Area Video Coalition (Bay Area Video Coalition (BAVC)) led a project to develop an open source tool to perform quality control on actual video content. It is available for download at their website.
Uncompressed 4:2:2, 10-bit (v210)	**Moderate Availability** Open source tools like MediaInfo could be used to ensure correct file characteristics. In order to evaluate the quality of the video content, commercial tools will probably be required. Also of note, Bay Area Video Coalition (Bay Area Video Coalition (BAVC)) led a project to develop an open source tool to perform quality control on actual video content. It is available for download at their website.
JPEG 2000 - Lossless	**Moderate Availability** Open source tools like MediaInfo could be used to ensure correct file characteristics. In order to evaluate the quality of the video content, commercial tools will probably be required. Support will vary due to lingering issues with interoperability. Also of note, Bay Area Video Coalition (Bay Area Video Coalition (BAVC)) led a project to develop an open source tool to perform quality control on actual video content. It is available for download at their website.
ffv1	**Moderate Availability** Open source tools like MediaInfo and ffprobe could be used to ensure correct file characteristics. Also of note, Bay Area Video Coalition (Bay Area Video Coalition (BAVC)) led a project to develop an open source tool to perform quality control on actual video content. It is available for download at their website.
MPEG-2 -	**Moderate Availability**

4:2:2 Profile/Main Level	Open source tools like MediaInfo could be used to ensure correct file characteristics. In order to evaluate the quality of the video content, commercial tools will probably be required. Also of note, Bay Area Video Coalition (Bay Area Video Coalition (BAVC)) led a project to develop an open source tool to perform quality control on actual video content. It is available for download at their website.

ATTRIBUTES: System Implementation Factors: Ease and Accuracy of Format Identification (defined by JHOVE as the format to which a digital object conforms)

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Can the format be identified using DROID/PRONOM or other tools?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Acceptable** Not supported by open source tools like JHOVE and DROID but is supported by propriety tools.
Uncompressed 4:2:2, 10-bit (v210)	**Acceptable** Not supported by open source tools like JHOVE and DROID but is supported by propriety tools.
JPEG 2000 - Lossless	**Acceptable** Not supported by open source tools like JHOVE and DROID but is supported by propriety tools.
ffv1	**Acceptable** Not supported by open source identification tools like JHOVE and DROID.
MPEG-2 - 4:2:2 Profile/Main Level	**Good** Supported by DRIOD (x/fmt 385 and 386) as well as commercial tools.

ATTRIBUTES: System Implementation Factors: Ease and Accuracy of Format Validation (defined by JHOVE as the level of compliance of a digital object to the specification for its purported format. Validation includes well-formedness.)

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Does the format specification include concepts and methods for conformance?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Poor** There are no tools that can perform this task.
Uncompressed 4:2:2, 10-bit (v210)	**Poor** There are no tools that can perform this task.
JPEG 2000 - Lossless	**Poor** There are no tools that can perform this task.
ffv1	**Poor** There are no tools that can perform this task.
MPEG-2 - 4:2:2 Profile/Main Level	**Poor** There are no tools that can perform this task.

ATTRIBUTES: Settings and Capabilities: Clarity

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Does the format support a variety of compression or encoding schemes? Are these schemes robust and thorough?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Acceptable** UYVY and YUY2 are fairly basic encodings that support video encodings up to 8-bits.
Uncompressed 4:2:2, 10-bit (v210)	**Good** v210 is a fairly robust encoding that supports SDI-like video.
JPEG 2000 - Lossless	**Good** JPEG2000 is a complex encoding scheme that supports various levels of granularity.
ffv1	**Good** ffv1 supports a wide range of encoding options.
MPEG-2 - 4:2:2 Profile/Main Level	**Acceptable** MPEG-2 @ 50Mbps provides a standard level of detail, but does use compression to eliminate some information.

ATTRIBUTES: Settings and Capabilities: Bit Depth

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: What bit depths does the format support, i.e. 8-bit and/or 10-bit?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Acceptable** Supports 8-bit only.
Uncompressed 4:2:2, 10-bit (v210)	**Good** Supports 10-bit only.
JPEG 2000 - Lossless	**Good** Supports 8 or 10-bit.
ffv1	**Good** Supports a range of bit depths from 8-14.
MPEG-2 - 4:2:2 Profile/Main Level	**Acceptable** Supports 8-bit only

ATTRIBUTES: Settings and Capabilities: Chroma Subsampling

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: What chroma subsampling is supported? Is this clearly declared in technical metadata?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Acceptable** Supports only 4:2:2 chroma subsampling
Uncompressed 4:2:2, 10-bit (v210)	**Acceptable** Supports only 4:2:2 chroma subsampling
JPEG 2000 - Lossless	**Good** Both 4:2:2 and 4:4:4 chroma subsampling are supported, as are others.
ffv1	**Good** Both 4:2:2 and 4:4:4 color spaces are supported, as is 4:4:0.
MPEG-2 - 4:2:2 Profile/Main Level	**Acceptable** Supports only 4:2:2 chroma subsampling

ATTRIBUTES: Settings and Capabilities: Audio Channels

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Can the format contain stereo audio, surround sound and other kinds of "aural space"? How many channels of audio are supported?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**N/A** The wrapper is typically responsible for providing this capability.
Uncompressed 4:2:2, 10-bit (v210)	**N/A** The wrapper is typically responsible for providing this capability.
JPEG 2000 - Lossless	**N/A** The wrapper is typically responsible for providing this capability.
ffv1	**N/A** The wrapper is typically responsible for providing this capability.
MPEG-2 - 4:2:2 Profile/Main Level	**N/A** The audio encoding is typically responsible for providing this capability.

ATTRIBUTES: Settings and Capabilities: Video Range

(Broadcast safe range or wide range/computer-graphics video)

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Does the format clearly declare whether it contains broadcast safe range video or computer graphics video?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**N/A** The wrapper is typically responsible for providing this capability.
Uncompressed 4:2:2, 10-bit (v210)	**N/A** The wrapper is typically responsible for providing this capability.
JPEG 2000 - Lossless	**N/A** The wrapper is typically responsible for providing this capability.
ffv1	**N/A** The wrapper is typically responsible for providing this capability.
MPEG-2 - 4:2:2 Profile/Main Level	**Acceptable** MPEG-2 can specify the full range of the video content by using the video_full_range_flag to indicate a full range of 0-255 values.

ATTRIBUTES: Additional Features

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Does the format support storage of additional data, beyond simply the audio and video essences?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**N/A** The wrapper is typically responsible for providing these capabilities.
Uncompressed 4:2:2, 10-bit (v210)	**N/A** The wrapper is typically responsible for providing these capabilities.
JPEG 2000 - Lossless	**N/A** The wrapper is typically responsible for providing these capabilities.
ffv1	**Acceptable** ffv1 version 3 has support for some additional features. Developers hope that this will help compensate for the shortcomings of some wrapper formats.
MPEG-2 - 4:2:2 Profile/Main Level	**Acceptable** MPEG-2 essences have some non-standardized means of incorporating additional data, but support for these features will vary depending on the applications in use.

ATTRIBUTES: Timecode

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Does the format have a specified location for timecode? Are breaks in timecode reflected? Can multiple timecodes can be stored?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**N/A** The wrapper is typically responsible for providing this capability.
Uncompressed 4:2:2, 10-bit (v210)	**N/A** The wrapper is typically responsible for providing this capability.
JPEG 2000 - Lossless	**N/A** The wrapper is typically responsible for providing this capability.
ffv1	**N/A** The wrapper is typically responsible for providing this capability.
MPEG-2 - 4:2:2 Profile/Main Level	**Good** SMPTE timecodes are embedded in the video stream which should allow for breaks in the timecode. Multiple timecodes can be stored between the metadata and the video stream.

ATTRIBUTES: Closed-captioning and Subtitles

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Does the format have a specified location for closed captions?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**N/A** The wrapper is typically responsible for providing this capability.
Uncompressed 4:2:2, 10-bit (v210)	**N/A** The wrapper is typically responsible for providing this capability.
JPEG 2000 - Lossless	**N/A** The wrapper is typically responsible for providing this capability.
ffv1	**N/A** The wrapper is typically responsible for providing this capability.
MPEG-2 - 4:2:2 Profile/Main Level	**Acceptable** Captions are stored in the "user data" or "private data" sections of a video elementary stream.

ATTRIBUTES: Scan Type and Field Order

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Does the format support both interlaced and progressive encoding? Does it clearly declare whether it is interlaced or progressive, and if interlaced, is field order clearly specified?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Poor** This encoding tends to be stored as progressive scan data. Unless metadata in the wrapper indicates otherwise, these encodings should be considered progressive.
Uncompressed 4:2:2, 10-bit (v210)	**Poor** This encoding tends to be stored as progressive scan data. Unless metadata in the wrapper indicates otherwise, these encodings should be considered progressive.
JPEG 2000 - Lossless	**Acceptable** The JPEG2000 standard does not clearly specify how to structure and declare content as interlaced or progressive. This is a known problem that significantly hampers interoperability. SMPTE is currently revising the relevant specification (ST 422) to add clarity to this situation.
ffv1	**Acceptable** Version 3 includes a 'picture_structure' field to declare whether video is interlaced or progressive and if interlaced, to specify field order.
MPEG-2 - 4:2:2 Profile/Main Level	**Good** This encoding can be flagged as interlaced or progressive using the 'Scan Type' field. If it is interlaced, field order can be specified using the 'Scan Order.'

ATTRIBUTES: Display Aspect Ratio

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Does the format clearly declare aspect ratio information, specifically display and pixel aspect ratio?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**Poor** This encoding does not provide information about aspect ratio or picture size.
Uncompressed 4:2:2, 10-bit (v210)	**Poor** This encoding does not provide information about aspect ratio or picture size.
JPEG 2000 - Lossless	**Acceptable** The JPEG2000 standard uses the Resolution box to declare a Display Aspect Ratio.
ffv1	**Acceptable** Version 3 supports wrapper-independent aspect ratio information.
MPEG-2 - 4:2:2 Profile/Main Level	**Good** This encoding uses square pixels and declares its aspect ratio as 4:3 or 16:9.

ATTRIBUTES: Multipart Essences

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Does the format support multipart essences?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**N/A** The wrapper is typically responsible for providing this capability.
Uncompressed 4:2:2, 10-bit (v210)	**N/A** The wrapper is typically responsible for providing this capability.
JPEG 2000 - Lossless	**N/A** The wrapper is typically responsible for providing this capability.
ffv1	**N/A** The wrapper is typically responsible for providing this capability.
MPEG-2 - 4:2:2 Profile/Main Level	**Acceptable** MPEG-2 Transport Streams offer the ability to multiplex multiple programs into one stream. There is good structural support for these multipart essences: a program association Table (PAT) is transmitted at regular intervals containing a list of all programs in the transport stream and is marked with a Picture ID (PID) of zero.

ATTRIBUTES: Essences Other Than Timed Data

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Is it possible to include formats other than the usual audio, video and data types found in reformatted video files?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**N/A** The wrapper is typically responsible for providing this capability.
Uncompressed 4:2:2, 10-bit (v210)	**N/A** The wrapper is typically responsible for providing this capability.
JPEG 2000 - Lossless	**N/A** The wrapper is typically responsible for providing this capability.
ffv1	**N/A** The wrapper is typically responsible for providing this capability.
MPEG-2 - 4:2:2 Profile/Main Level	**N/A** The wrapper is typically responsible for providing this capability.

ATTRIBUTES: Fixity Checks

- Scoring conventions: Good, Acceptable, Poor
- Questions to Consider: Does the format have a means to support fixity checks?

Uncompressed 4:2:2, 8-bit (UYVY and YUY2)	**N/A** The wrapper is typically responsible for providing this capability.
Uncompressed 4:2:2, 10-bit (v210)	**N/A** The wrapper is typically responsible for providing this capability.
JPEG 2000 - Lossless	**N/A** The wrapper is typically responsible for providing this capability.
ffv1	**Acceptable** Version 3 has FLAC-like CRC checks at the frame and slice level. Version 1 doesn't have CRC enforcement, but includes decoding alarms.
MPEG-2 - 4:2:2 Profile/Main Level	**Acceptable** MPEG-2 supports embedded CRCs, but depending on the applications in use this may interfere with interoperability.