Federal Agencies Digitization Guidelines Initiative

Digital File Formats for Videotape Reformatting

Part 3. Detailed Matrix for Encodings (unified large table)

This table presents all of the information in a single table to facilitate comparisons. All pages after this cover are intended for printing on 11x17-inch paper. Part 4 provides the same information on multiple, easily printable pages.

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The FADGI Audio-Visual Working Group

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

Digital File Formats for Videotape Reformatting: Part 3. Detailed Matrix for Encodings

ATTRIBUTES	Scoring Conventions	Considerations	Uncompressed 4:2:2, 8-bit (UYVY and YUY2) 8-bit UYVY, also known as 2vuy YUY2, also known as yuvs	Uncompressed 4:2:2, 10-bit (v210) 10-bit v210	JPEG2000 - Lossless 8 or 10-bit lossless Broadcast Profiles within the set in Amendment 3	ffv1 Version 1 stable since 2006 Version 3 incorporates new features like checksums	MPEG-2 - 4:2:2 Profile/Main Level ISO/IEC 13818-2 4:2:2 Profile/Main Level, 50 Mbps, I-frame only
Sustainability Factors							
Disclosure	Good Acceptable Poor	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?	**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.	**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. SMPTE ST 377 also offers some additional information about this encoding.	**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 (format 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).	**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	**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.
Adoption	Low Moderate Wide	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?	**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.	**Wide** Many cultural heritage institutions use these formats for preservation purposes. Vendors also offer good support for the format.	**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.	**Moderate** Initially used as an intermediate format (Version 1), but beginning to be used for preservation work (Version 3). It has been adopted in the cultural heritage and open-source communities. Usage in Europe is spreading especially quickly. Additionally, there are a growing number of software tools that can work with the format- ffmpeg and MediaInfo, for example. The City of Vancouver Archives, the National Archives UK, National Television of Slovakia (RTVS and National Radio and Television of Slovenia) all use ffv1 for preservation purposes.	**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.
Transparency	Good Acceptable Poor	Transparency refers to the degree to which the digital object is open to direct analysis with basic tools.	**Good** Fairly transparent. UYVY and YUY2 are easily understood and identified free file analysis and playback software like MediaInfo and VLC.	**Good** Fairly transparent. v210 is easily understood and identified by free file analysis and playback software like MediaInfo and VLC.	**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 free file analysis and playback software tools like MediaInfo and VLC.	**Acceptable** Fairly transparent. It can be analyzed using the free tools ffprobe, MediaInfo and VLC.	**Good** Relatively transparent. MPEG-2 is easily understood and identified by free file analysis and playback tools like MediaInfo and VLC.
Self-Documentation	Good Acceptable Poor	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?	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**Acceptable** High wrapper dependency. Revision of SMPTE ST 422 will provide more clarity around scan type and field order.	**Acceptable** High wrapper dependency. Version 3 will be less dependent on the wrapper because it will include information such as display aspect ratio.	**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.
Native Embedded Metadata Capabilities	Good Acceptable Poor	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?	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**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 display 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).	**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.	**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.
Impact of Patents	Possible Impact No Impact	Are there patents related to this format that could have a direct impact on the long-term sustainability of files produced in this format?	**No Impact** None	**No Impact** None	**No Impact** None (assuming Core Coding, Part 1 of the specification)	**No Impact** None	**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.
Technical Protection Mechanisms	Possible Impact No Impact	Are there technical protection measures inherent to this format that would prohibit the creation of ample derivatives/other formats?	**No Impact** No documentation that says YUY2 or UYVY have specific encryption capabilities.	**No Impact** No documentation that says v210 has specific encryption capabilities.	**No Impact** Digital Cinema formats rely heavily on encryption, but most likely this is done by the wrapper.	**No Impact** The encoding itself doesn't provide technical protections.	**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).

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Cost Factors							
Implementation Cost	High Medium Low	How expensive is it to capture, edit, store and move these files?	**Low** Well-supported and fairly simple. The costs for implementing these formats are typically low.	**Medium** Well-supported, but format does require some additional overhead.	**Medium** Well-supported by commercial tools, but somewhat complicated. Format may require additional costs to implement.	**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.	**Low** Well-supported by both free software and commercial tools. The costs for implementing this format are typically low.
Cost of Software	Low= Free Medium= $500+ High= $1000+ Even though you can capture video with software alone, robust hardware makes capturing video faster and better.	How much does capture and editing software cost? Is free software available? (With the exception of VirtualDub, all software must be accompanied by an encoding card.)	**Low to Medium** Free software such as ffmpeg and VirtualDub can be used to capture and edit UYVY and YUY2 encodings. Many commercial software tools can also capture and edit UYVY and YUY2 encodings. The cost can range from moderately inexpensive to fairly pricey.	**Low to Medium** Free software tools such as ffmpeg, VirtualDub and vrecord can capture to v210. Many commercial software tools can also capture and edit v210. The cost can range from moderately inexpensive to fairly pricey.	**Low to High** Free software tools such as vrecord can capture to JPEG2000. Commercial software tools that capture to JPEG2000 tend to be fairly pricey.	**Low** Some free software tools have been created to capture to ffv1. These include vrecord, the BBC's Ingex system and Austrian National Audio/Video Archive's DVA-Profession system.	**Low to Medium** Free software tools can be used to capture and edit MPEG-2. Many commercial software tools can also capture and edit MPEG-2 encodings. The cost can range from moderately inexpensive to fairly pricey.
Cost of Hardware	Low=up to $1000 Medium= $1000+ High= $10000+ Even though you can capture video with cheap hardware, more robust hardware makes capturing/editing faster and better.	How much does capture and editing hardware cost? Are low-cost tools sufficient?	**Low to Medium** It is possible to capture to these formats with fairly cheap, generic hardware. However, you may be able to achieve better performance with more robust hardware.	**Low to Medium** It is possible to capture to this format with fairly cheap, generic hardware. However, you may be able to achieve better performance with more robust hardware.	**Low to Medium** Most of the tools used to capture to JPEG2000 will require a fee. The cost can vary from moderate to fairly pricey.	**Low to Medium** It is possible to create this format with generic hardware. Also interesting to note is that of all the lossless codecs, ffv1 requires the least amount of computer resources for transcoding. Specifically, it takes 4-6 times less computing time to transcode from an ffv1 file to a mezzanine or intermediate file type.	**Low to Medium** It is possible to create this format with generic hardware.
Storage Cost	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 or ffv1 = about 53 GB 1 hour of MPEG-2 @ 50Mbps = 23 GB	Are files created in this format usually large, medium, or small in size?	**High** These files are large and uncompressed; they will require significant storage resources.	**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.	**Medium** These files are losslessly compressed so they will require slightly less storage.	**Medium** These files are losslessly compressed so they will require slightly less storage.	**Low** These files use lossy compression and will take up significantly less space than uncompressed or lossless compression.
Network Cost	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.	Does the transfer of files in this format affect performance of internal networks to the point where it would cost more to implement this format?	**High** These files are large and may slowdown or overwhelm internal networks.	**High** These files are large and may slowdown or overwhelm internal networks.	**Medium** These files use lossless compression and will probably transfer in about real-time.	**Medium** These files use lossless compression and will probably transfer in about real-time.	**Low** These files use lossy compression and will probably transfer at rates faster than real-time.
System Implementation Factors (Full Lifecycle)							
Level of difficulty/complexity to implement	High Medium Low	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?	**Low** Fairly easy to implement. Both commercial and free software tools offer consistent support for a variety of tasks including playback, metadata manipulation and transcoding.	**Low** Fairly easy to implement. Both commercial and free software tools offer consistent support for a variety of tasks including playback, metadata manipulation and transcoding.	**Medium** Lingering issues with interoperability and a range of proprietary implementations of this format are problematic. Commercial software tools will probably be required and may support only limited flavors of the format.	**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.	**Low** Many tools support the MPEG-2 encoding. More advanced features will require the use of commercial tools.
Technical Complexity of Toolsets	High Medium Low	Are the tools command-line meant for engineers or GUI-centered applications accessible to the average user?	**Low** Tools are well-developed and typically run from a GUI.	**Low** Tools are well-developed and typically run from a GUI.	**Medium** Format is somewhat complex and will require specialized tools. Familiarity with the format will be required to successfully implement it.	**Medium** Some tools require technical expertise. They may run from a command-line instead of a GUI and may require less common platforms such as Linux. Commercials tools that are easier to implement are becoming more numerous also.	**Low** Familiarity with this format will facilitate successful implementation. Tools that support this format are well-developed and typically run from a GUI.
Availability of Tools for: Rendering/playback Editing	Wide availability Moderate availability Limited availability	Are there tools available for this format? What is the mix of free software and commercial tools?	**Wide Availability** Good support from free software tools including VLC. Commercial software usually supports this format as well.	**Wide Availability** Good support from free software tools including VLC. Commercial software usually supports this format as well.	**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.	**Wide Availability** Good support from free software tools including VLC and ffplay. Commercial tools increasingly support the ffv1 codec.	**Wide Availability** Good support from free software tools including VLC.
Availability of Tools for: Metadata extraction Metadata embedding	Wide availability Moderate availability Limited availability	Are there tools available for this format? What is the mix of free software and commercial tools? What level of effort is necessary in order to extract or embed metadata?	**Wide Availability** Good support for metadata extraction from free software tools including MediaInfo. Support for metadata embedding depends on the wrapper in use.	**Wide Availability** Good support for metadata extraction from free software tools including MediaInfo. Support for metadata embedding depends on the wrapper in use.	**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.	**Wide Availability** Good support for metadata embedding and extraction from free software tools including ffmpeg. Commercial tools increasingly support the ffv1 codec.	**Wide Availability** Good support for metadata extraction from free software tools including MediaInfo. Support for metadata embedding will probably require commercial tools.
Availability of Tools for: Transcoding	Wide availability Moderate availability Limited availability	Are there tools available for this format? What is the mix of free software and commercial tools? What level of effort is necessary in order to transcode?	**Wide Availability** Relatively easy to create derivatives and new preservation formats. A good mix of free and commercial software tools can transcode from this format. ffmpeg is an example of a free tool that can perform these transcodes.	**Wide Availability** Relatively easy to create derivatives and new preservation formats. A good mix of free software and commercial tools support transcodes from this format. ffmpeg is an example of a free tool that can perform these transcodes.	**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.	**Moderate Availability** Free software tools 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 increasingly support ffv1 as well.	**Wide Availability** Relatively easy to create derivatives and new preservation formats. A good mix of free software and commercial tools support transcodes from this format. ffmpeg is an example of an free software tool that can perform these transcodes.
Availability of Tools to: Measure Compliance with Institutional Specifications	Wide availability Moderate availability Limited availability	How easy is it to ensure that you are producing a file that conforms to your institutional specifications?	**Wide Availability** Free software tools like MediaInfo and AVI MetaEdit can extract technical metadata which can be compared against institutional specs. Commercial tools can also do this work.	**Wide Availability** Free software tools like MediaInfo can extract technical metadata which can be compared against institutional specs. Commercial software tools can also do this work.	**Wide Availability** Free software tools like MediaInfo can extract technical metadata which can be compared against institutional specs. Commercial software tools can also do this work.	**Wide Availability** Free software tools like MediaInfo and ffprobe can extract technical metadata which can be compared against institutional specs. Commercial tools can also do this work.	**Wide Availability** Free software tools like MediaInfo can extract technical metadata which can be compared against institutional specs. Commercial software tools can also do this work.
Availability Tools to: Tools to Evaluate and Monitor Content Quality	Wide availability Moderate availability Limited availability	How easy is it to ensure that you are producing a file that conforms to broadcast specifications or other quality measures?	**Moderate Availability** Free software 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 a free software tool to perform quality control on actual video content. It is available for download at their website.	**Moderate Availability** Free software tools like MediaInfo could be used to ensure correct file characteristics. In order to evaluate the quality of the video content, commercial software tools will probably be required. Also of note, Bay Area Video Coalition (Bay Area Video Coalition (BAVC)) led a project to develop a free software tool to perform quality control on actual video content. It is available for download at their website.	**Moderate Availability** Free software 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 a free software tool to perform quality control on actual video content. It is available for download at their website.	**Moderate Availability** Free software 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 a free software tool to perform quality control on actual video content. It is available for download at their website.	**Moderate Availability** Free software tools like MediaInfo could be used to ensure correct file characteristics. In order to evaluate the quality of the video content, commercial software tools will probably be required. Also of note, Bay Area Video Coalition (Bay Area Video Coalition (BAVC)) led a project to develop a free software tool to perform quality control on actual video content. It is available for download at their website.
Ease and Accuracy of Format Identification (Defined by JHOVE as the format to which a digital object conforms)	Good Acceptable Poor	Can the format be identified using DROID/PRONOM or other tools?	**Acceptable** Not supported by free software tools like JHOVE and DROID but is supported by commercial tools.	**Acceptable** Not supported by free software tools like JHOVE and DROID but is supported by commercial tools.	**Acceptable** Not supported by free software tools like JHOVE and DROID but is supported by commercial tools.	**Acceptable** Not supported by free software identification tools like JHOVE and DROID.	**Good** Supported by DROID (x/fmt 385 and 386) as well as commercial tools.

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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.)	Good Acceptable Poor	Does the format specification include concepts and methods for conformance?	**Poor** There are no tools that can perform this task.	**Poor** There are no tools that can perform this task.	**Poor** There are no tools that can perform this task.	**Poor** There are no tools that can perform this task.	**Poor** There are no tools that can perform this task.

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Settings and Capabilities (Pass/Fail)							
Clarity	Good Acceptable Poor	Does the format support a variety of compression or encoding schemes? Are these schemes robust and thorough?	**Acceptable** UYVY and YUY2 are fairly basic encodings that support video encodings up to 8 bits.	**Good** v210 is a fairly robust encoding that supports SDI-like video.	**Good** JPEG2000 is a complex encoding scheme that supports various levels of granularity.	**Good** ffv1 supports a wide range of encoding options.	**Acceptable** MPEG-2 @ 50Mbps provides a standard level of detail, but does use compression to eliminate some information.
Bit Depth	Good Acceptable Poor	What bit depths does the format support, i.e. 8-bit and/or 10-bit?	**Acceptable** Supports 8-bit only.	**Good** Supports 10-bit only.	**Good** Very versatile in this respect. Format supports a wide range of bit depths from about 8 to 24-bit.	**Good** Supports a range of bit depths from 8-16 in YUV color spaces and up to 14-bits in RGB color spaces..	**Acceptable** Supports 8-bit only
Chroma Subsampling	Good Acceptable Poor	What chroma subsampling is supported? Is this clearly declared in technical metadata?	**Acceptable** Supports only 4:2:2 chroma subsampling	**Acceptable** Supports only 4:2:2 chroma subsampling	**Good** Very versatile in this respect. Format supports 4:2:2, 4:4:4 and many others.	**Good** Very versatile in this respect. Format supports 4:2:2, 4:4:4 and many others. Ffv1 also supports an alpha channel in both YUV and RGB color spaces.	**Acceptable** Supports only 4:2:2 chroma subsampling
Audio Channels	Good Acceptable Poor	Can the format contain stereo audio, surround sound and other kinds of "aural space"? How many channels of audio are supported?	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The audio encoding is typically responsible for providing this capability.
Video Range (Broadcast safe range or wide range/computer-graphics video)	Good Acceptable Poor	Does the format clearly declare whether it contains broadcast safe range video or computer graphics video?	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**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.
Additional Features	Good Acceptable Poor	Does the format support storage of additional data, beyond simply the audio and video essences?	**N/A** The wrapper is typically responsible for providing these capabilities.	**N/A** The wrapper is typically responsible for providing these capabilities.	**N/A** The wrapper is typically responsible for providing these capabilities.	**Good** ffv1 version 3 has support for some additional features. These additional features may the codec more robust and flexible.	**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.
Timecode	Good Acceptable Poor	Does the format have a specified location for timecode? Are breaks in timecode reflected? Can multiple timecodes can be stored?	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**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.
Closed-captioning and Subtitles	Good Acceptable Poor	Does the format have a specified location for closed captions?	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**Acceptable** Captions are stored in the "user data" or "private data" sections of a video elementary stream.
Scan Type and Field Order	Good Acceptable Poor	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?	**Poor** This encoding tends to be stored as progressive scan data. Unless metadata in the wrapper indicates otherwise, these encodings should be considered progressive.	**Poor** This encoding tends to be stored as progressive scan data. Unless metadata in the wrapper indicates otherwise, these encodings should be considered progressive.	**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.	**Good** Version 3 includes a 'picture_structure' field to declare whether video is interlaced or progressive and if interlaced, to specify field order.	**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.'
Display Aspect Ratio	Good Acceptable Poor	Does the format clearly declare aspect ratio information, specifically display and pixel aspect ratio?	**Poor** This encoding does not provide information about aspect ratio or picture size.	**Poor** This encoding does not provide information about aspect ratio or picture size.	**Acceptable** The JPEG2000 standard uses the Resolution box to declare a Display Aspect Ratio.	**Good** Version 3 supports wrapper-independent aspect ratio information.	**Good** This encoding uses square pixels and declares its aspect ratio as 4:3 or 16:9.
Multipart Essences	Good Acceptable Poor	Does the format support multipart essences?	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**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.
Essences Other Than Timed Data	Good Acceptable Poor	Is it possible to include formats other than the usual audio, video and data types found in reformatted video files?	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.
Fixity Checks	Good Acceptable Poor	Does the format have a means to support fixity checks?	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**N/A** The wrapper is typically responsible for providing this capability.	**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.	**Acceptable** MPEG-2 supports embedded CRCs, but depending on the applications in use this may interfere with interoperability.