IS 562 AO SP20: Metadata in Theory & Practice (McDonough, J)

Technical Metadata Analysis

Amelia Ishmael

This assignment focuses on Technical Metadata, a subcategory of the Administrative Metadata for information resources. For this project we will analyze select metadata fields that are included in sample PBCore and MIX records. These two schemas standards were both developed to address particular community needs for more complete technical-attribute information. Previous schemas, focusing more in descriptive and access metadata, were found to be insufficient for digital still image and audio-video metadata needs. PBCore and MIX are often used alongside other standards, such as DC, PREMIS, DACS/EAD, and MODS.

The PBCore schema was developed by the Corporation for Public Broadcasting as a standard for use with AV materials. This record describes the video file "File8.mp4" and was generated using the file characterization tool MediaInfo. For the PBCore record we will focus on the Instantiation elements and the Instantiation sub-element Essence (since this record focuses on Technical Metadata it has taken pbcoreInstantiationDocument as its root element rather than taking pbcoreDescriptionDocument as its parent, which would facilitate additional Descriptive Metadata).

Referring to the documentation offered in the source XML file, "instantiationDigital element is used to identify the format of a particular instantiation [or 'manifestation'] of an asset [or 'work'] as it exists as a digital file on a server, hard drive, or other digital storage medium. Digital instantiations should be expressed as a formal Internet MIME types." [1] The value of instantiationDigital in our digital resource is "video/mp4." Mp4 is a filename extension for MPEG-4, an open-standard file-format "for coding of audio-visual objects;" It was developed by the Moving Picture Experts Group.[2] More information for this format is described further in the attribute instantiationAnnotation annotationType="Inform", which confirms that the file format is "MPEG-4 (Base Media / Version 2)." This information is important to guide users to what sort of encoding is used for the data file, what sort of technical environment would be required to display the file, and what sort of preservation concerns exist.

instantiationStandard is the used to express the standard used for the broadcast video signal or the audio encoding for physical instantiations, or the container format of the digital file. This information would guide users to Like the instantiationDigital element, this information is important to guide users to what sort of encoding is used, the technical requirements for access (such as what sort of program would be needed to unwrap the data) and display, and preservation concerns. Since our source file's standard has already provided in instantiationDigital, this information has been opted omitted.

---

[1] *PBCore Handbook* (http://pbcore.org/assets/downloads/handbook/PBCore_Handbook_Full.pdf), 53.
[2] "MPEG-4 File Format, Version 2," *Sustainability of Digital Formats: Planning for Library of Congress Collections*, https://www.loc.gov/preservation/digital/formats/fdd/fdd000155.shtml

The rest of the sub-elements that we will analyze are contained within the instantiationEssenceTrack element. The information within this grouping describes individual tracks (or "streams") that are included in an instantiation (such as audio, video, captions); It can pertain to physical or digital formats.[3]

Like the instantiationStandard, the essenceTrackStandard describes the standard used for the signal or format of the track described, and is frequently used for physical instantiations (such as analogue video). This information is important for user access, technical access and display requirements, and preservation concerns. This element is not included in our sample; Rather than utilizing this optional sub-element, the digital video and audio tracks of our digital file are each described through an essenceTrackEncoding sub-element.

essenceTrackEncoding identifies the scheme used to compress the tracks included within our instantiation. This information is relevant for enhancing users' access, describing how the file will be decompressed, and informing sharing capabilities.[4] Our sample file includes two track types: video and audio.

essenceTrackDataRate "measures the amount of data used per time interval for encoded data." The value of this sub-element is numerical, and is determined by dividing the track's total data size by a time unit. This value informs playback speed. For our sample file, the video Data Rate is 300000 bits/second; for the audio is the Data Rate is 64000 bits/second (and is based on CBR, "constant bit rate" encoding).

essenceTrackFrameRate is a sub-element used for video tracks (it does not apply to audio tracks). Its numerical value is determined by dividing the total number of frames by the duration of the track. In our sample file, the Video Frame Rate is 23.976. (There is additional information about the Frame Rate in Annotations.) This value also informs the playback speed. Default fps is 24, which is about the frame rate that allows humans to perceive a "moving image" rather than a sequence of still images.

essenceTrackFrameSize measures the height and width of the encoded pixels on the video track (it does not apply to audio tracks).[5] The Frame Size of our sample file is 320x176; This means that the video is 320 pixels wide and 176 pixels high. This information is vital for gleaning proper playback resolution; The video should not be displayed at a larger or small size, if it aspires to be an authentic performance.

essenceTrackAspectRatio provides a ratio of horizontal to vertical image proportions (it does not apply to audio tracks). Our sample video's Aspect Ratio is 1.818. This information effects the video's display quality; If a video is performed at a different aspect ratio it will appear distorted or "stretched."

---

[3] *PBCore Handbook*, 59.
[4] *PBCore Handbook*, 61.
[5] *PBCore Handbook*, 64.

ColorSpace is an attribute of the sub-element essenceTrackAnnotation. This value is a mathematical definition that describes the Photometric Interpretation required for an accurate human perception of the display representation. Color Space can be visualized as a color model that maps the spectrum of colors that are within its scope of capabilities.[6] The Color Space of our sample file is described as "YUV" (luma, blue, and red). Historically YUV has been used for analogue encoding, and video encoding (including MPEG format such as we have here) has used YCbCr; Currently these distinct Color Space encodings are used *as though* they are interchangeable. (It would be healthy skepticism to suspect that the metadata that MediaInfo supplied for our sample file is inaccurate and that it should follow the MPEG standard of YCbCr.)[7]

ChromaSubsampling is also an attribute of the sub-element essenceTrackAnnotation. It is used to describe the subsampling efforts that have been applied to the digital file in order to decrease the file size of the MPEG and facilitate file storage. Basically color information (particularly in the blue and red spectrum) are omitted from the file to decrease the file size (and thus facilitate video file storage and transmission), but without significantly decreasing perceived image quality loss. The value of the video track of our sample file is 4:2:0. Here 4 is the width of the sampling region, 2 is the number of chrominance samples taken within the first row of the signal, and 0 declares that there were no samples taken in the second row of the signal. This 4:2:0 sample ratio is the same as that used for DVDs. [8]

PixelAspectRatio is also an attribute of the sub-element essenceTrackAnnotation. It describes the ratio of the height:width of the file's pixels, and thus appends the information provided in the essenceTrackAspectRatio element.[9] The Pixel Aspect Ratio of our sample file is 1.000, which means that the pixels should be displayed with equal height and width, i.e. square.

The MIX schema, as specified in the *Data Dictionary - Technical Metadata for Digital Still Images (ANSI/NISO Z39.87-2006)*, is a standard for use to document Digital Still Images. It was developed by the Library of Congress to address the community's need for enhanced documentation of technical attributes of, particularly "to validate, manage, migrate, and process master-image files of enduring value."[10] Our sample record describes the still image file "mix20.xsd" and was generated using the metadata tool FITS. For this MIX record we will analyze aspects of Compression from the elements for Basic Digital Object Information, the yCbCr container for elements of Basic Image Information, and ImageColorEncoding container for elements and sub-elements of Image Assessment Metadata.

---

[6] Jerome McDonough and Jimi Jones, "A Guide to Some of the Image Technical Metadata Terminology In MIX," 3.
[7] See Charles Poynton, "YUV and luminance considered harmful" (2008), http://poynton.ca/PDFs/YUV_and_luminance_harmful.pdf cited in "YUV," *Wikipedia* https://en.wikipedia.org/wiki/YUV
[8] "A Guide to Some of the Image Technical Metadata Terminology In MIX," 4-5.
[9] "Pixel Aspect Ratio," *Wikipedia*, https://en.wikipedia.org/wiki/Pixel_aspect_ratio
[10] *Data Dictionary - Technical Metadata for Digital Still Images (ANSI/NISO Z39.87-2006)*, http://groups.niso.org/apps/group_public/download.php/17937/ANSI-NISO%20Z39.87-2006%20%28R2017%29%2C%20Data%20Dictionary%20-%20Technical%20Metadata%20for%20Digital%20Still%20Images.pdf, 2.

Image Color Encoding (or Photometric Interpretation) included sub-elements that include Bits per Sample and Samples per Pixel, White Point, and Primary Chromaticities (for Red, Green, and Blue). These sub-elements record information about the digital resource that describe how to achieve accurate reproductions of luminosity and color profiles by mapping between display devices and perception normalizations.

The CompressionScheme element is wrapped within the Compression container, it specifies the specific compression scheme that has been used to store the image data.[11] Since the compression scheme manipulates the byte order of the file, its algorithm must be documented in order for the image to be accessed and displayed accurately. This information is also crucial for preservation processes, in order to determine file specific migration workflows. The value of the Compression Scheme of our sample file is "JPG." (Referring the previous element, the Format Registry container, we may append our understanding with the information that this JPG has been identified as PRONOM fmt/43, which is the JPEG File Interchange Format, Version 1. The byte order for this file format is "big endian.")[12]

Next, we'll analyze some of the elements in the YCbCr container. As we identified in the previous PBCore record, YCbCr describes the encoding of the Color Space used for our sample file. YCbCrSubSampling is one of the data elements wrapped in this container. This element "designates the subsampling factors used for the chrominance components of a YCbCr image."[13] Our sample record contains two values in this element yCbCrSubsampleHoriz "2" and yCbCrSubsampleVert "2." According to the TIFF 6.0 Specification these two fields are valuable factors to understand the subsampling. In yCbCrSubsampleHoriz a "2" indicates that the "ImageWidth of this chroma image is half the ImageWidth of the associated lumaimage." In yCbCrSubsampleVert a "2" indicates that "ImageLength (height) of this chroma image is half the ImageLength of the associated luma image."[14] Since both of these values are 2, we know that the chrominance samples were taken at the same location as the luminance samples.[15] When the value for the colorSpace element is "YCbCr" the YCbCrSubSampling, YCbCrPositioning, and YCbCrCoefficients elements are mandatory. The YCbCrPositioning elements describe the positions of the subsampled components in relation to the luminance samples. The tag value of this element in our sample file is "1" (or, "centered"), which is the default value for this field. The final section of the YCbCr container that needs described is the YCbCrCoefficients element, which represents the coefficients within the transition from RGB to YCbCr image data. It contains three values lumaRed, lumaGreen, and LumaBlue; Together these values were used to compute the luminance Y where $Y = (LumaRed * R + LumaGreen * G + LumaBlue * B)$. In our sample file, lumaRed=299/1000, lumaGreen=587/1000, and lumaBlue=114/1000. These values follow the default values specified by the *CCIR Recommendation 601-1*, "Encoding Parameters of Digital Television for Studios."[16] These YCbCr container specifications are vital

---

[11] *ANSI/NISO Z39.87-2006* (6.6.1), 12.
[12] "Details for: JPEG File Interchange Format 1.01," *The National Archives*, http://www.nationalarchives.gov.uk/PRONOM/PUID/proPUIDSearch.aspx?status=listReport
[13] *ANSI/NISO Z39.87-2006* (6.6.1), 23.
[14] TIFF 6.0 Specification (Adobe Developers Association, 1992), https://web.archive.org/web/20150503034412/http://partners.adobe.com/public/developer/en/tiff/TIFF6.pdf, 91-92.
[15] "A Guide to Some of the Image Technical Metadata Terminology In MIX," 5.
[16] TIFF 6.0 Specification, 91.

to understanding the Color Space encoding of the file, and thus ensuring effective bandwidth of the samples, proper post-processing methods, and accurate display of the digital image.[17]

Finally, the ImageColorEncoding container for elements and sub-elements of Image Assessment Metadata. The first element is BitsPerSample, which is a container for two data elements designating Value and Unit. Our sample file describes that the value of each components for the three color planes is "8" bits per sample, using the Unit as being measured in "integer" values. The SamplesPerPixel element for a YCbCr file must have a value of "3" (which our sample file affirms). This element designates the number of color components per pixel, here representing the 3 components (Y, Cb, and Cr) per pixel.[18] Within the WhitePoint element there are two sub-elements: WhitePoint_Xvalue and WhitePoint_Yvalue. Within a YCbCr Color Field, white is not available—a point in the Color Field must thus be used to represent "white" and stand in for its intended display. "Knowing what color has been selected as white point is critical to correct display of image data."[19] The WhitePoint_Xvalue of our sample file is 3127/10000, and the WhitePoint_Yvalue is 3290/10000; 3127,3290 represents the XY coordinate of the default white within the Color Space for the sample image file. The PrimaryChromaticities container is the last section that we will analyze. This container comprises 6 data elements that may be paired into three sets: PrimaryChromaticities_RedX and PrimaryChromaticities_RedY, PrimaryChromaticities_GreenX and PrimaryChromaticities_GreenY, and PrimaryChromaticities_BlueX and PrimaryChromaticities_BlueY. These fields define the X,Y coordinates that designate the exact red, green, and blue hues that are present within the digital file image, and thus represent the chromaticities of the image's primary colors within the file's RGB Color Space.[20] "These values can correspond to the chromaticities of the phosphors of a monitor, the filter set and light source combination of a scanner or the imaging model of a rendering package."[21] The *CCIR Recommendation 709* primaries are: Red 640/1000,330/1000; Green 300/1000, 600/1000; and Blue 150/1000, 60/1000.[22] Our sample file matches this Recommendation, with the slight variation of Green's X value being "290" rather than 300. Our display device must be able to represent these chromaticities in order to affirm an accurate representation of the digital image file.

[17] TIFF 6.0 Specification, 92.
[18] *ANSI/NISO Z39.87-2006* (6.6.1), 75; TIFF 6.0 Specification, 94.
[19] "A Guide to Some of the Image Technical Metadata Terminology In MIX," 7-8.
[20] A Guide to Some of the Image Technical Metadata Terminology In MIX," 9.
[21] TIFF 6.0 Specification, 84.
[22] Ibid.