ONTOLOGY FOR MEDIA CREATION
PART 3A: CAMERA METADATA

VERSION 2.8

Contents

1 Introduction

Picture and sound are not the only valuable data captured on a set. Metadata that tells how the picture and sound were captured is equally important and is used to help the interpretation of that data downstream of the set. Camera Metadata is a type of Digital Asset.

For image data, the camera metadata describes, among other things, the shooting configuration of the camera. For example, whether the camera was set to record log or linear color. This is necessary for the correct interpretation of the data. If log curve images are interpreted as linear color, the result is a very 'flat' image. Correctly interpreting log color requires knowledge of the log curve[1] that was used in the camera when the image was recorded.

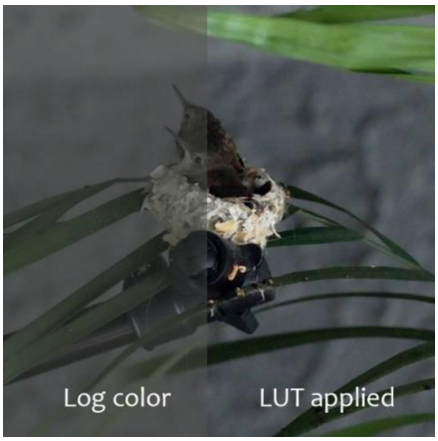

Figure 1-1 Camera metadata is used to determine the LUT[2] to apply to a log image

Historically, much of the useful metadata about the camera configuration has been passed on in the notes from the camera operator. However, cameras in use today record metadata, including their settings. In the case of the image above, the camera metadata indicated it was set to log and the version of the log curve, information that was used to "develop" the image.

Camera metadata often contains information about other parts of the capturing system. Some lenses are equipped with a means for the camera to read the settings such as aperture and focus distance. Metadata from the recorder is also important as are external inputs such as timecode.

[1] For an explanation of how log curves work, see https://www.rocketstock.com/blog/tips-for-log-color-space-compositing/

[2] Look Up Table – see Terms section

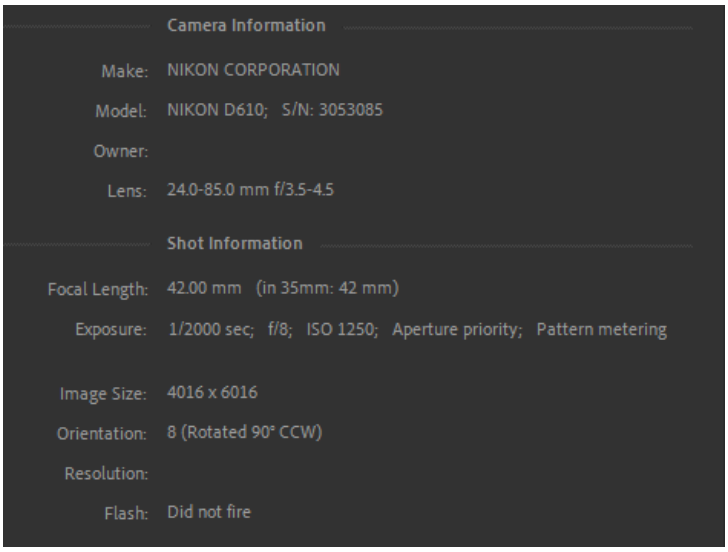

Figure 1-2. Example of camera metadata captured by a DSLR[3]

Figure 1-1 shows the metadata recorded by a Nikon DSLR. The camera model, serial number and lens are recorded along with metadata specific to that shot.

This document provides some definitions of common terms and classes to represent metadata from the camera system. It also describes how some other components of the Ontology can be used to provide input to the camera and how metadata from the camera system is used by other components of the Ontology.

Scope

This document defines a set of camera metadata that is required in downstream processes including dailies and finishing, as well as VFX and Virtual Production. Other groups, such as SMPTE's Rapid Industry Solutions program for On Set Virtual Production (RIS OSVP), are creating standards for specific application areas that may be more detailed than this document.

It is not a definitive list. Some of the metadata created by the cameras is either specific to the camera model or expressed in terms that are specific to the camera model. Color is an example of this. This document defines metadata terms for tint, white balance, saturation, and slope. However, ARRI cameras and RED cameras, for example, both have a richer set of metadata available for color, but the expression of the color parameters is specific to each camera maker. This document does not include camera metadata used only in broadcast environment.

[3] With still images, the metadata is often stored in the image file.

Static and Dynamic Metadata

The metadata described in this document is primarily static, meaning it is time invariant between the start of recording and the end of recording. However, some metadata will change and will be recorded as such in the systems that are recording the metadata.

Obviously, each frame has a different Timecode, but other parameters may also change, for example, the Focal Length of a zoom lens and the Focus Position.

Terms

These definitions are informative, and the ones below are normative.

Term	Terse Definition	Notes
Camera	Motion picture camera	Digital unless otherwise noted as a film camera
LUT	Look up table	A look up table is an array, either two or three dimensional, that changes the way an image looks. For example, a LUT can be used to transform an image from one color space to another
ISO	The rating of the sensitivity of film or a camera sensor to light.	The higher the ISO value, the more sensitive the film or camera imager is to light. Digital cinema cameras are often rated at 800. "ISO" is a reference to the standards body that codified the scale.
EI	Exposure index	Where ISO is the rating of the film or sensor, EI is the rating at which the exposure was made. For example, if we have a camera rated at 800 ISO and we are shooting in subdued light, we might choose to expose the image as though the imager was 1250 ISO. The EI is then used when the image is "developed" to correct for the difference.
Shutter angle	A measure of the exposure time of an image relative to the frame rate. $0 < \text{shutter angle} \leq 360$	Film cinema cameras use a rotating mechanical shutter that is a disc with a sector cut out and rotated one turn per frame. When the cut out passes over the film, the film is exposed to light. The most common shutter angle is 180 degrees which exposes the film for 50% of the time. If the frame rate is 24 fps, a 180-degree shutter angle would mean the exposure is $1/48^{th}$ sec. This measurement is used with digital cameras although, with one exception, digital cameras have electronic shutters.

Term	Terse Definition	Notes
Timecode	A linear sequence of numeric codes generated at a regular interview and usually recorded in the format *hour:minute:second:frame*	
FDL	Framing Decision List	The American Society of Cinematographers' FDL is a set of instructions for how to view content in any application. The ASC FDL provides a mechanism to document framing decisions through all phases of a production's life cycle, from pre-visualization through post-production.
Mag	Magazine	Originally, the detachable part of a film camera that held the film. With digital cameras, it means the container that holds the recording media when it is inserted into the camera or the recorder.
f-stop or f-number	The size of the lens aperture.	Ratio of the focal length to the diameter of the aperture. The smaller the f-stop, the larger the aperture.
T-stop	The f-stop adjusted to account for light transmission efficiency	The T-stop is the f-stop corrected by a manufacturer for actual light transmission of all the lens elements, rather than the nominal aperture opening size.
FPS	Frames per second	The frequency at which consecutive images (frames) are recorded or played back.
Frame rate	Synonymous with FPS	
Lens	A device containing a series of curved glass elements used to focus light on the camera imager or film.	
Recorder	A device to record to media the images captured by the camera.	The media is, for example, a solid-state disk (SSD) or CFast[4] media. May be integrated into the camera.

Notational Conventions

In documents generally:

- The definition of a term included in the Dictionary is in bold, followed by the definition, e.g., **Creative Work:** A uniquely identified production.
- When a defined term is used in the text of a document, it is capitalized, for example in "The Production Scene is usually derived from a numbered scene in the Script," Production Scene and Script are defined in the Ontology. (Note, a word that is part of defined term may sometimes be

[4] https://en.wikipedia.org/wiki/CompactFlash#CFast

capitalized by itself as a shorthand, e.g., “Scene” may be used to indicate “Narrative or Production Scene.”)

- References to other Ontology Documents are in ***bold italic***, e.g., ***Part 3: Assets*** or ***Part 3A: Camera Metadata.***

For Sample Attributes in the concept documents:

- If a data field or attribute is formally defined in this ontology or a connected ontology, it is italicized, e.g., *Setup* as an attribute refers to a defined concept.
- Attribute […] indicates an attribute can appear more than once, e.g., *Identifier* […]
- →Thing means that an attribute is expressed as a relationship to a Thing, e.g., →*Script*
- A combination of the two indicates that the concept can have relationships to a set of things, e.g., →Components […]
- Many elements of the Ontology have a Context element. (See **Part 2: Context**.) Relationships declared in the Context are implied to have the item to which the Context is attached as their starting point. For example, Narrative Location→Context→Narrative Scene

  For clarity, contextual relationships that are especially important to the concept being defined are given in the sample attributes tables as C→target or C→target […] as appropriate, for example Narrative Location→Narrative Scene

  Some implementations (e.g. RDF) place these relationships directly on the class as well as allowing them in Context, and others (e.g. JSON) place all relationship in a Context.

Concepts

A digital camera is a complex piece of equipment, and has multiple components: the Lens, the Camera, and either a Recorder and Mag or just a Mag. The Lens and Camera have device-specific information (make, model, etc.) and information about a particular capture. The Recorder has device-specific information and an identifier for any removable storage media (the Mag).

All of the classes have fields for both structured and unstructured representations of data not covered by the standard attributes.

The camera metadata includes a link to an FDL. Some camera and lens metadata attributes may also appear in the FDL however since an FDL may not be present, this duplication is unavoidable. Precedence is a matter for the user.

Camera, Lens, and Recorder Metadata are all Asset Functional Classes. Assets that use them will generally have Asset Structural Characteristics that are some form of digital data (See ***Part 3: Assets***),

which represents the file or other kind of storage that holds the original information generated by the device.

Camera Metadata

Camera Metadata: Capture-specific details and information about the Camera itself.

Sample Attributes for Camera Metadata

Attribute	**Description**
Identifier […]	One or more identifiers for the Camera Metadata. At least one of these should be resolvable within the production environment.
Name	
Description	
Attributes	See below. The Attributes are listed separately for formatting reasons; they are all individual fields, not an Array.
Custom Data	Anything that is application or workflow dependent that can't be otherwise expressed in the Ontology or needs to be present in a particular format.
→ *Context* […]	Context related to this Asset Functional Characteristic
C->*Slate*	Camera metadata is usually associated with a particular capture, and hence with a Slate.
C->*Camera*	The Camera that generated this metadata; see ***Part 8: Infrastructure***.

Term	**Definition**
Capture Rate	The number of individual images captured per second
Playback Rate	The number of individual images per second of the intended playback speed.
Timecode	Timecode for each frame
Timecode Start	Timecode when recording started
Timecode End	Timecode when recorded stopped
Shutter Angle	A measure of the exposure time of an image relative to the frame rate. 0 < shutter angle ≤ 360

Term	Definition
ISO Speed	Arithmetic ISO scale as defined in ISO 12232
Exposure Index	Exposure index is the ISO rating used to determine exposure when the recording was made.
Reel Name	A name assigned to a sequence of recorded images
Camera Make	The manufacturer or vendor of the camera
Camera Model	The manufacturer's name for the camera model. For example, the name of the camera family followed by the name of the variant.
Camera UID	An alphanumeric code that uniquely identifies the camera among all cameras from all vendors
Camera Serial Number	An alphanumeric code assigned by the manufacturer to a camera
Camera Firmware Version	An alphanumeric code that identifies the firmware installed in the camera at the time of recording
Camera Label	Human readable ID assigned to each production camera.
Frame Width	The height of the intended image in pixels. This may or may not be the height of the recorded image or the sensor
Frame Height	The width of the intended image in pixels. This may or may not be the width of the recorded image or the sensor
FDL Link	Unique identifier of the FDL used by the camera
Active Sensor Physical Dimensions	Height and width of the active area of the camera sensor
Pixel Aspect Ratio	Describes how the pixels are to be interpreted to correctly display the image.
Flip - X	The flip-X factor indicates whether the image is flipped horizontally.
Flip - Y	The flip-Y factor indicates whether the image is flipped vertically.

Term	Definition
LUT UID	An alphanumeric code that uniquely identifies the LUT loaded into the camera and applied to the monitor output during shooting.
Tint	Defines the R/B white points against the green channel.
White Balance	The color temperature of white expressed in degrees Kelvin
Tilt	The angle of a camera off its pitch axis, measured in degrees when the camera is level
Roll (Dutch)	The angle of the camera off of the roll axis, measured in degrees when the camera is level
Camera Roll	Identifier for a group of events captured together on the same camera and recording media.
Circle Take	Indicating whether a recorded sequence of images is considered a candidate for use.

Notes:

Structured and Unstructured Metadata have been removed since they are covered by Custom Data in the Asset.

Lens Metadata

Lens Metadata: Capture-specific details and information about the Lens itself.

Sample Attributes for Lens Metadata

Attribute	Description
Identifier […]	One or more identifiers for the Lens Metadata. At least one of these should be resolvable within the production environment.
Name	
Description	
Attributes	See below. The Attributes are listed separately for formatting reasons; they are all individual fields, not an Array.
Custom Data	Data or metadata for a particular Functional Class.
→ *Context* […]	Anything that is application or workflow dependent that can't be otherwise expressed in the Ontology or needs to be present in a particular format.

C->*Camera*	The Camera associated with this Lens when the Lens Metadata was generated, if relevant; see ***Part 8: Infrastructure***.
C->*Lens*	The Lens that generated this metadata; see ***Part 8: Infrastructure***.

Term	Definition
T-Stop	The linear T-number of the lens, equal to the f-number of the lens divided by the square root of the transmittance of the lens
f-Stop	The linear f-number of the lens, equal to the focal length divided by the diameter of the entrance pupil
Entrance Pupil Position	Entrance pupil position of the lens
Focus Position	Focus distance/position of the lens
Focal Length	The actual focal length of the lens, in millimeters, when the image was captured. With a zoom lens this may be change frame by frame.
Lens Make	The lens manufacturer or vendor
Lens Model	The lens model identifier assigned by the lens manufacturer or vendor
Anamorphic Squeeze	Nominal ratio of height to width of the image of an axis-aligned square captured by the camera sensor
Lens Serial Number	A number unique to each lens from the same manufacturer or vendor and of the same model
Lens Firmware Version	Version identifier for the firmware of the lens

Notes:

Structured and Unstructured Metadata have been removed since they are covered by Custom Data in the Asset.

Recorder Metadata

Recorder Metadata: Information about a Recorder and the recording media.

Sample Attributes for Recorder Metadata

Attribute	Description
Identifier […]	One or more identifiers for the Recorder Metadata. At least one of these should be resolvable within the production environment.
Name	
Description	
Attributes	See below. The Attributes are listed separately for formatting reasons; they are all individual fields, not an Array.
Custom Data	Data or metadata for a particular Functional Class.
→ *Context* […]	Anything that is application or workflow dependent that can't be otherwise expressed in the Ontology or needs to be present in a particular format.
C->*Camera*	The Camera associated with this Lens when the Lens Metadata was generated, if relevant.
C->*Recorder*	The Recorder that generated this metadata; see ***Part 8: Infrastructure***.

Sample Attributes (no change from v1.0)

Name	Definition
Recorder Firmware Version	An alphanumeric code that identifies the firmware installed in the recorder at the time of recording
Recorder Make	The recorder manufacturer or vendor
Recorder Model	The recorder model identifier assigned by the lens manufacturer or vendor
Recorder Serial Number	A number unique to each recorder from the same manufacturer or vendor and of the same model
Storage Media UID	An alphanumeric code that uniquely identifies the storage media (i.e., mag) the footage was recorded on to.

Notes:

Structured and Unstructured Metadata have been removed since they are covered by Custom Data in the Asset.

Interaction with Other Parts of the Ontology

Some of the data recorded by the Camera system is equivalent to information defined elsewhere in the Ontology. The flow of information goes in both directions. For instance, information about the Creative Work, such as its Director and Title, can be entered into many cameras. In the other direction, some of the information provided by the Camera is used in the Slate.

Creative work

These are taken from the Creative Work being filmed.

Name	**Use**
Title	The Title of the Creative Work can be input into a Camera. This can be a code name or in the case television a series and episode number.

Slate-related

The following fields of Slate are often provided in the Camera Metadata.

Name	**Definition**
Slate UID	An alphanumeric code that uniquely identifies a single clip by combining the Scene Descriptor, Setup, and Take. Provided by some Cameras.
Scene Number	The number of the scene. Can be provided by some cameras.
Shoot Date	The date the footage was captured
Camera Unit	A group of Participants responsible for shooting some element of a Scene, e.g., Main Unit or Second Unit.

Some components of the Slate UID are provided by some cameras.

Name	**Definition**
Scene Descriptor	The Scene Descriptor of the Production Scene being shot.
Setup	A setup is the unique camera configuration that encompasses a camera's geo-location, positioning, lens, or other camera settings.
Take	The events captured from the time the camera is “rolling” to the time it is stopped. A director may require multiple takes of a Production Scene with a particular setup.

Location

Production Location is found in the Context Ontology.

Name	Definition
Production Location	A real place that is used to depict the narrative location or used for creating the production. Can be provided by some Cameras.

Participant

These are all defined in the Participants Ontology and can be entered on some Cameras.

Name	Definition
Director	The Camera Unit's director
Cinematographer	The Camera Unit's cinematographer
Camera Operator	The operator of the camera that recorded the footage

Appendix A Revisions From v1.0

In addition to updating this document as part of the MovieLabs Ontology for Media Creation, the following changes were made from v1.0.

1. Alignment with names and definitions used in SMPTE *RIS OSVP Camera and Lens Metadata Parameters for VFX*.
2. Removal of mappings to metadata definitions for three cameras from Red, ARRI and Sony. It was too small a set of camera makers and models; in general, it is not feasible to keep track of vendor's metadata definitions.
3. Removal of mappings to *VES 1.1* and *SMPTE 2650-4* as additional standards are emerging. The mapping to SMPTE *RIS OSVP Camera and Lens Metadata Parameters for VFX* is inherent in the changes made in this version.

Camera Metadata Revisions From v1.0

Term	Definition	Change from v1.0
Capture Rate	The number of individual images captured per second	*Renamed. Was Recording FPS.*
Playback Rate	The number of individual images per second of the intended playback speed.	*Renamed. Was Playback FPS.*
ISO Speed	Arithmetic ISO scale as defined in ISO 12232	*Revised Definition.*

Term	Definition	Change from v1.0
FDL Link	Unique identifier of the FDL used by the camera	*New.*
Active Sensor Physical Dimensions	Height and width of the active area of the camera sensor	*New.*

Lens Metadata Revisions From v1.0

Term	Definition	Change for v1.0
T-Stop	The linear T-number of the lens, equal to the f-number of the lens divided by the square root of the transmittance of the lens	*Renamed. Was Aperture. Definition revised.*
f-Stop	The linear f-number of the lens, equal to the focal length divided by the diameter of the entrance pupil	*New.*
Entrance Pupil Position	Entrance pupil position of the lens	*New.*
Focus Position	Focus distance/position of the lens	*Renamed. Was Focus. Definition revised.*
Anamorphic Squeeze	Nominal ratio of height to width of the image of an axis-aligned square captured by the camera sensor	*Renamed. Was Lens squeeze. Definition revised.*
Lens Firmware Version	Version identifier for the firmware of the lens	*New.*