



Color Processing with OpenColorIO v2 and the Academy/ASC Common LUT Format

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ENGINEERING EXCELLENCE

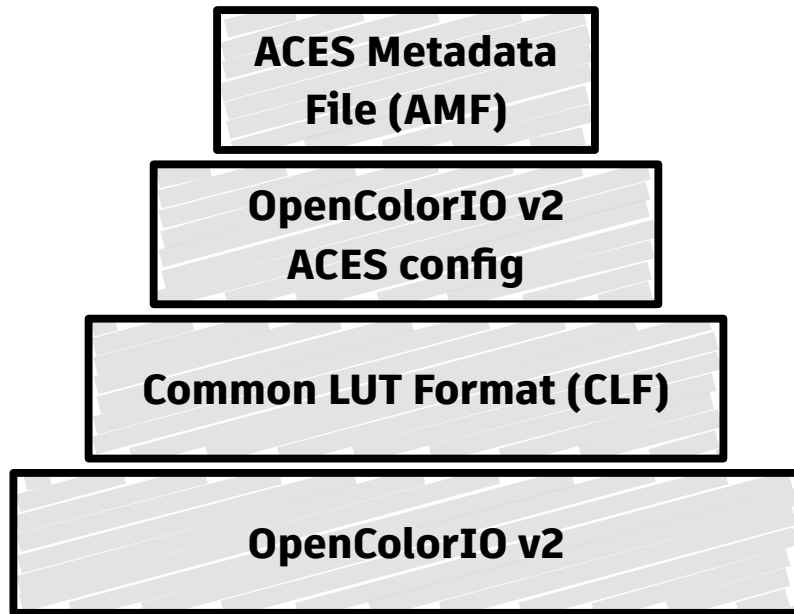
“OpenColorIO v.2”


Autodesk

H&A
AWARDS 2021

Technology Stack

This talk explores OpenColorIO and CLF via a case study of how to implement AMF





The recipe and all
ingredients are freely
available!

Try this at home with
 pythonTM

Download the
accompanying tutorial
from the HPA website
along with these slides!



ACES Metadata File color pipeline

Today's Recipe: AMF Color Pipeline

Ingredients:

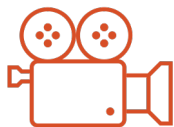
- 1 ACES Metadata File parser
- 2 OpenColorIO v2 ACES config file
- 3 Academy/ASC Common LUT Format
- 4 OpenColorIO v2 color processing engine



ACES Metadata File (AMF)

ACES Metadata File (AMF)

Provides key information to properly interpret its accompanying media



What color
space is the
media in?



What Looks
should be
applied?

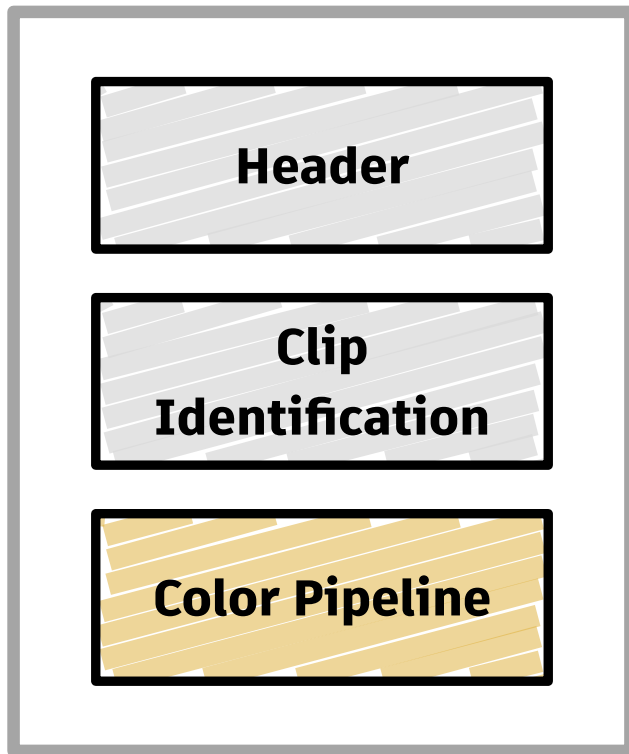


How should it
be viewed?

ACES Metadata File (AMF)

An XML side-car file for media

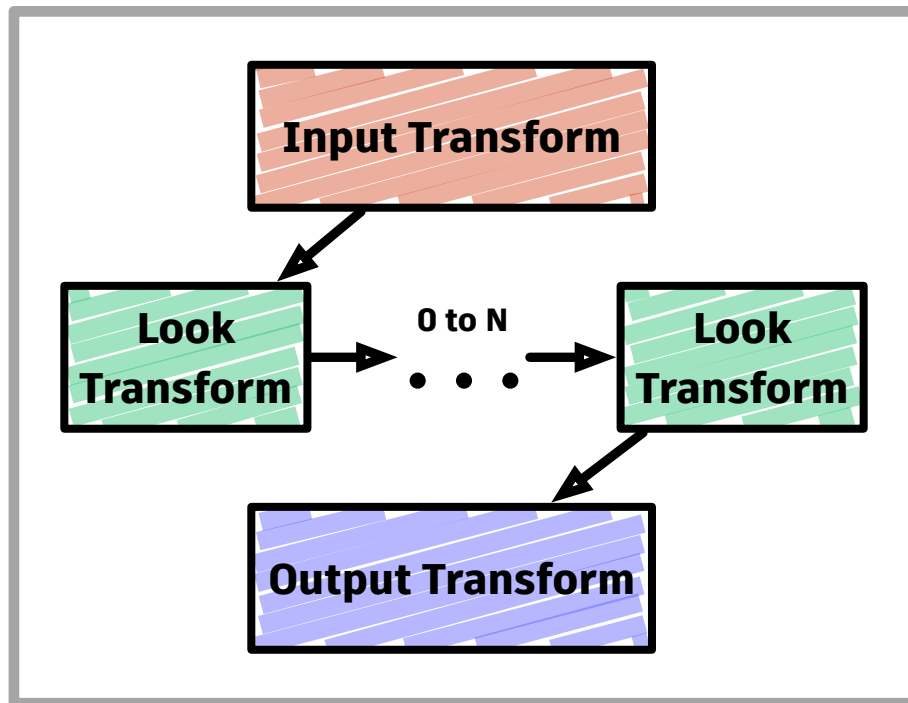
AMF File Contents



ACES Metadata File (AMF)

A color pipeline *description*

**AMF
Color
Pipeline**

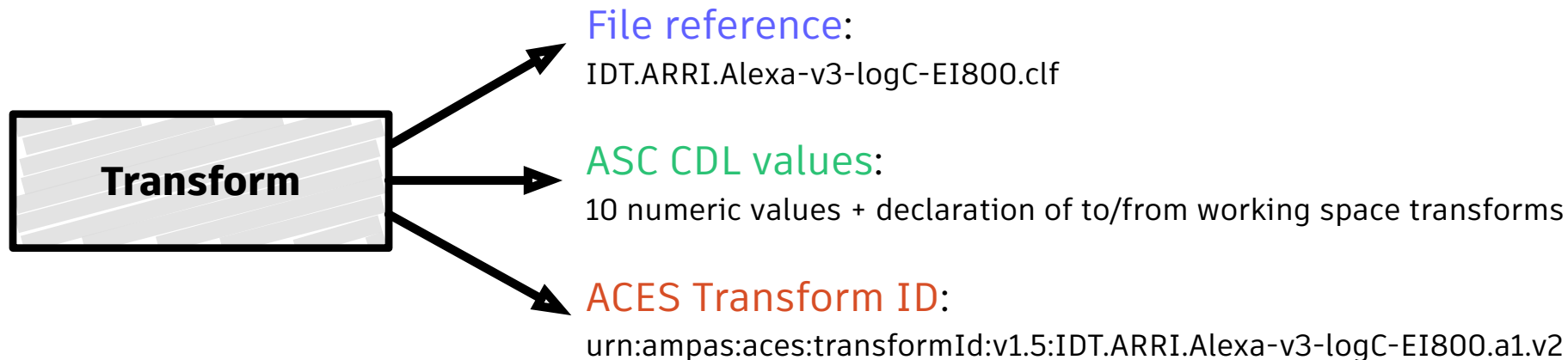


* Each transform may be flagged as “*applied*” or “*not applied*”

** Connection space between transforms is ACES2065-1

ACES Metadata File (AMF)

There are three methods of declaring transforms



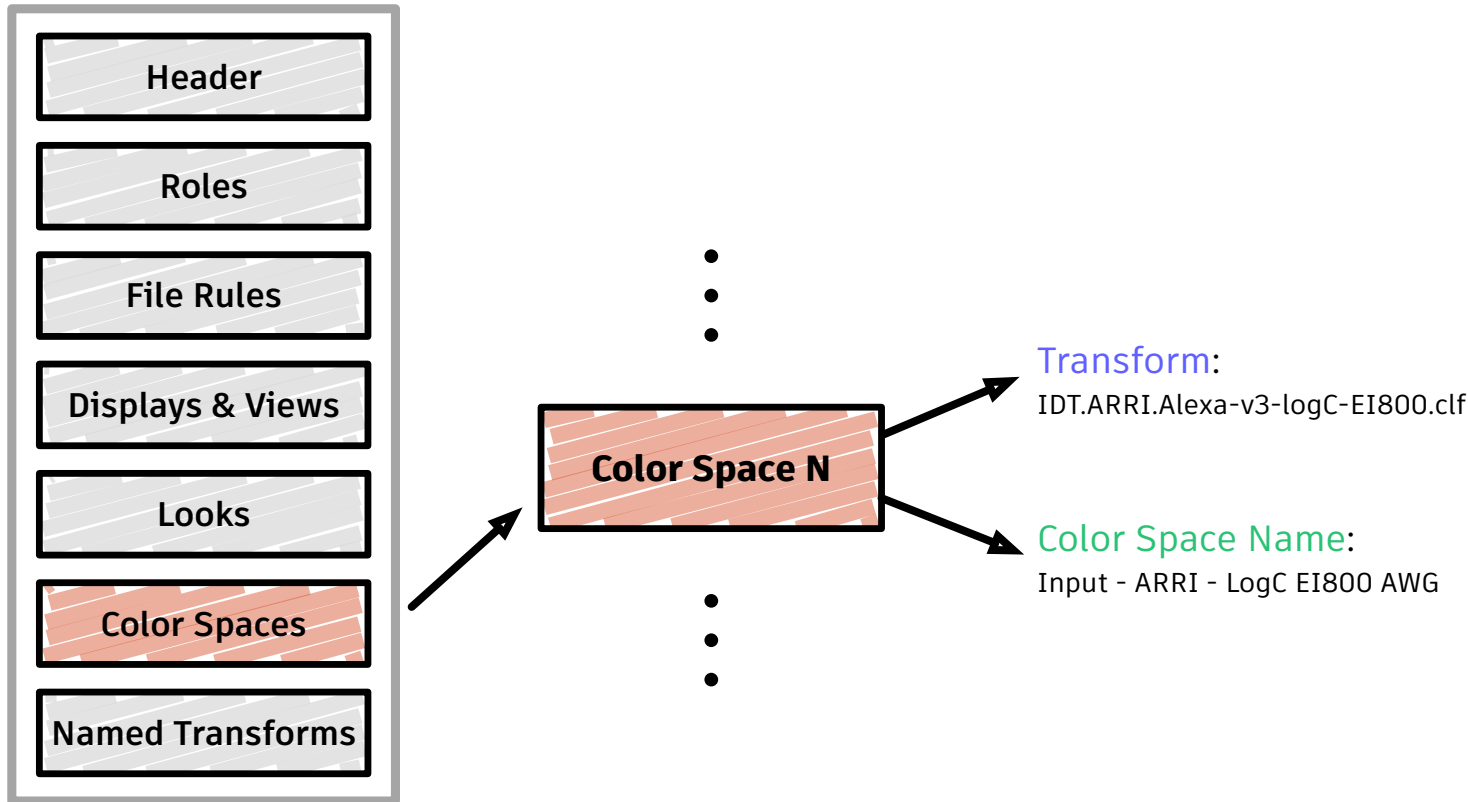


OpenColorIO v2 ACES configs

OpenColorIO v2 “config” file

Defines the color environment to be used for a project/show

OCIO v2 Config File Contents



OpenColorIO v2 ACES config files

Deliverables in progress by the OCIO Configs working group



ACES Reference config

- Intended as a reference tool for engineers
- OCIO's implementation of the reference CTL code on the Academy GitHub site
 - Input Transforms (IDTs)
 - Output Transforms (RRT/ODTs)
 - Looks
- No external LUT files



ACES CG config

- Intended for CG artists using common DCC tools
- Subset of the Ref. config
 - ACES working spaces
 - Most common Output Transforms
 - Adds CG texture spaces
- No external LUT files



ACES Studio config

- Intended for artists needing the full ACES suite plus other common transforms
 - Will supplant the OCIO v1 ACES config
 - Better accuracy than v1
 - Better artist user experience
- More compact external files (450 MB → less than 45 MB)

OpenColorIO v2 ACES config files

Advantages over OCIO v1 ACES config

- Most transforms are now built into OCIO v2 and no longer require external LUTs
- Better accuracy, especially for very bright colors
- Improved user experience for artists
- Will use the Academy/ASC Common LUT Format (CLF) for external files
 - Reaching out to camera vendors, in partnership with the Academy
 - Opportunity to document Transform IDs not currently in the Academy GitHub site
- ***May be used as a Transform ID database for implementing AMF***



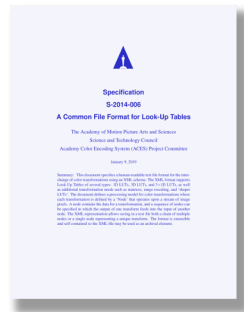
Academy/ASC Common LUT Format (CLF)

Academy/ASC Common LUT Format (CLF)

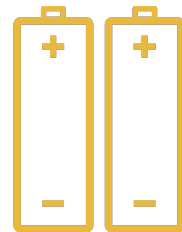
Yet another LUT format? Here's why!

222.125
0.18752
-0.0042

Handles
scene-linear,
floating-point
color spaces



Thoroughly
documented



Implementation
test kit



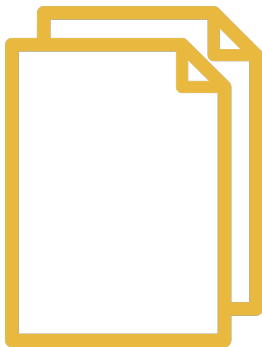
High-quality
open source
implementation
via OCIO v2



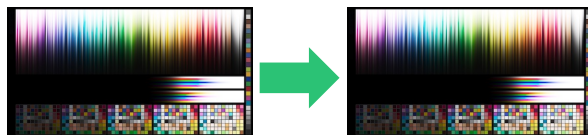
Must be an archival element

Academy/ASC Common LUT Format (CLF)

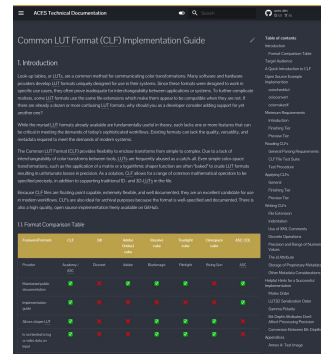
The ACES CLF Implementation working group has completed its deliverables



Sample
CLF files



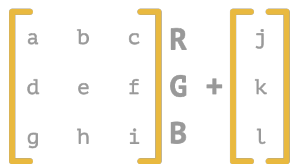
Processed
test images



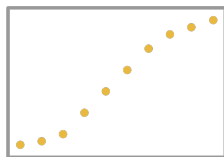
Implementation
Guide

Academy/ASC Common LUT Format (CLF)

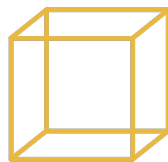
Rich & flexible processing pipeline



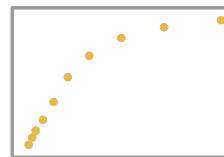
Matrix
plus offset



Lut1D



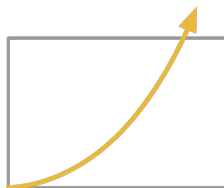
Lut3D



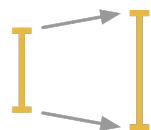
half-float
Lut1D



ASC CDL



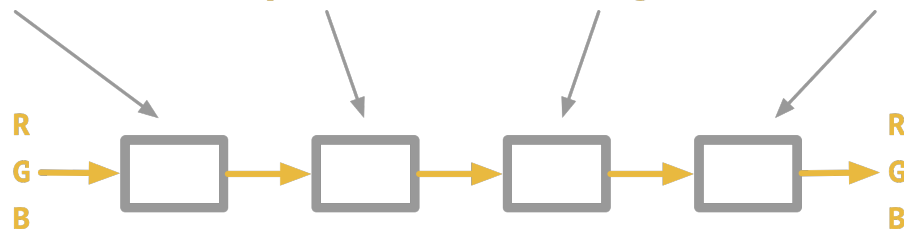
Exponent



Range



Log



OpenColorIO v2



OpenColorIO (OCIO)

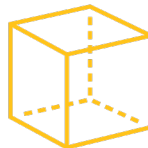
Key benefits



**Document the
color pipeline for
a project/show**



**Encourage a
consistent user
experience for
artists**



**Process various
industry LUT
formats**

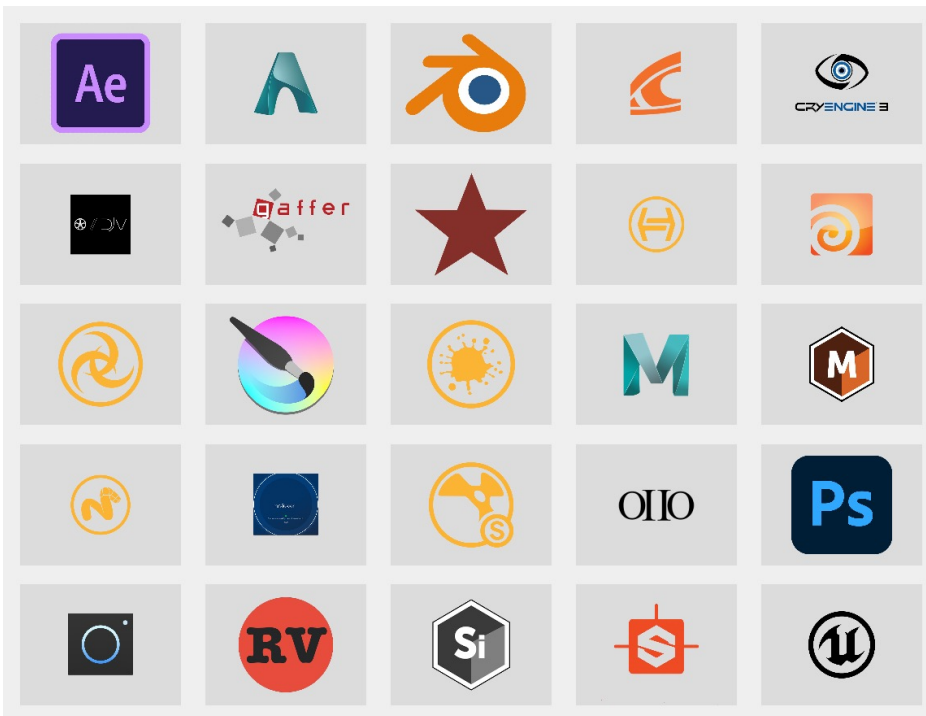


**Process pixels on
CPU & GPU**

OpenColorIO v1

A brief history

- Released by Imageworks in 2011
 - Started development in roughly 2003
- Supported by dozens of apps
 - Maya, Nuke, Unreal Engine, ...
- Used on hundreds of films
 - Virtually every VFX-oriented film in recent years
- Adopted into the ASWF in 2019



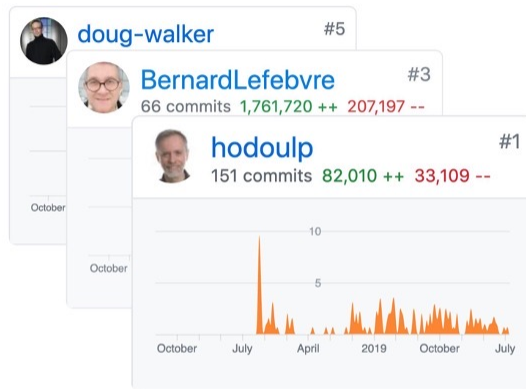
Revitalizing an important open source project

OCIO v2 working group

3 full-time Autodesk devs



ARRI, DNEG, Epic,
Framestore, ILM,
Imageworks, Netflix,
Sony, Weta, ...



OpenColorIO v2

New feature highlights

- New GPU renderer (now matches CPU)
- CPU optimizations (up to 20x faster)
- Better user experience for artists
- Built-in support for ACES transforms
- Full read/write Academy/ASC CLF support
- ICC monitor profile support
- 3d-LUT inversion
- Display-referred reference space
- Serialize arbitrary transforms to a file
- Group color spaces by categories
- File rules to assign color space to images
- Viewing rules to assign view based on image encoding
- Improved transform chain optimization
- Vastly improved (10x) unit test coverage

OpenColorIO v2 Processing Model

- Like CLF, allows an arbitrary pipeline of color math building block “ops”
- Even richer operator collection than CLF
 - Allows exact shader math for all ACES transforms
- All ops may be evaluated identically on CPU and GPU
 - In both forward and inverse directions!
- Processing pipelines are optimized before being applied
 - Fine-grained user control of the optimization process



Example pipeline showing a variety of ops in arbitrary order

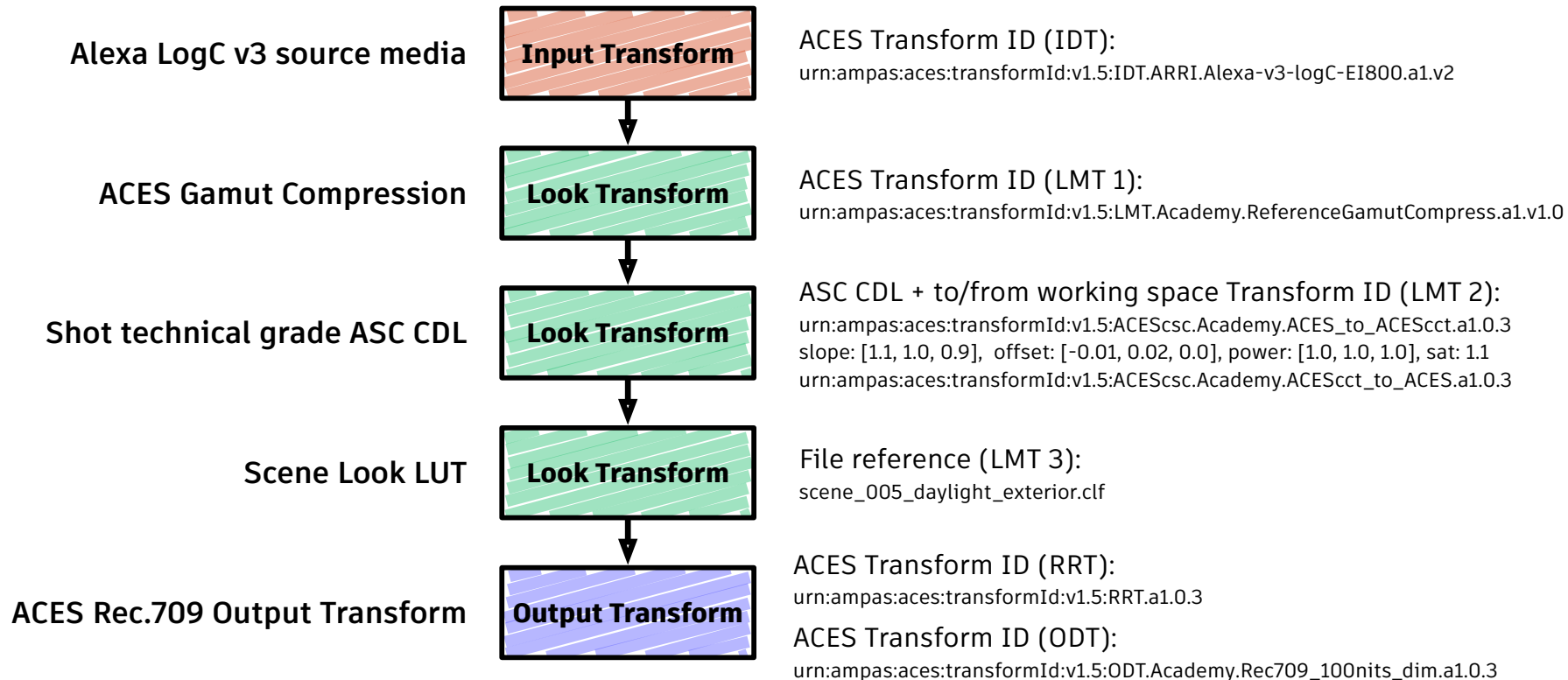


AMF Color Pipeline

(Time to get cooking!)

AMF Color Pipeline Example

Demonstrates all transform types



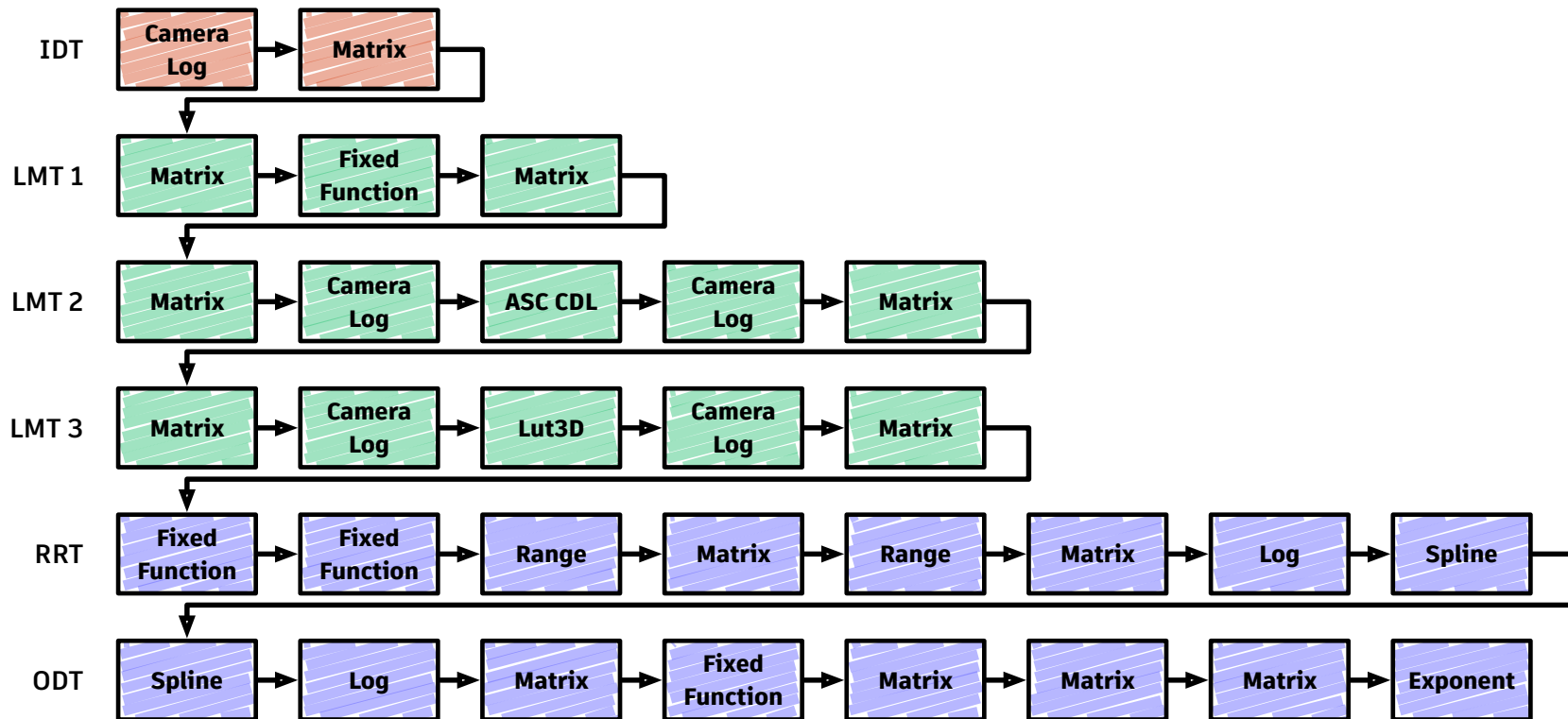
Processing the AMF

Steps to convert an AMF into an OpenColorIO v2 pipeline

- 1 Parse the AMF file (use the provided script or any XML parser)
- 2 Load the OCIO v2 ACES Reference config file
- 3 Use config file to search for ACES Transform IDs and build transforms
- 4 Locate any external LUT files and parse using OCIO v2
- 5 Assemble all transforms into an OCIO v2 color pipeline

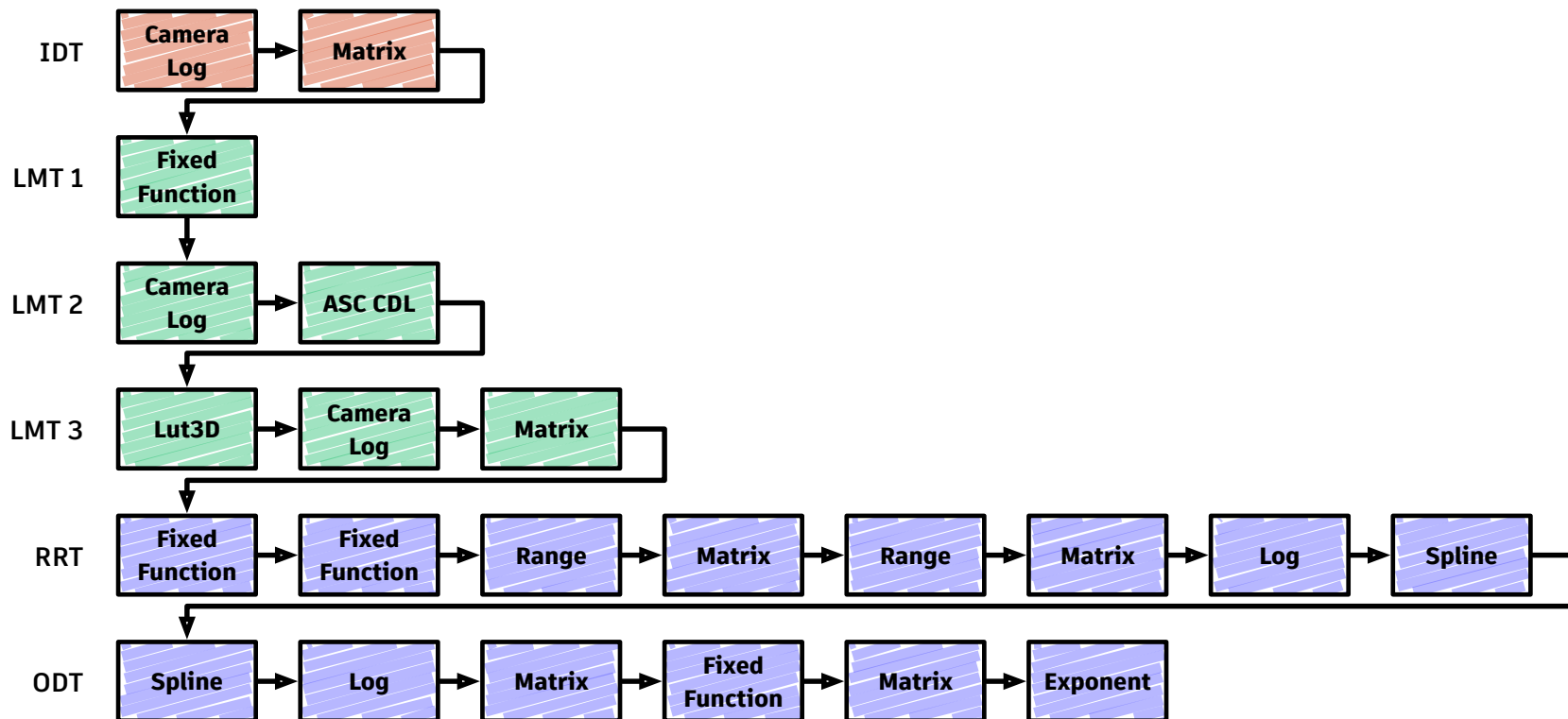
AMF Color Pipeline Example

Initial color pipeline of atomic “ops” needed to implement the example



AMF Color Pipeline Example

Color pipeline after lossless optimization pass



Ready to Eat!

Our recipe is complete




The AMF file has
been converted
to an OCIO v2
color pipeline



The resulting
pipeline may be
applied in real-
time on the GPU



The pipeline may
be serialized into
OCIO's native
XML file format
(based on CLF)



The recipe and all
ingredients are freely
available!

Try this at home with
 pythonTM

Download the
accompanying tutorial
from the HPA website
along with these slides!

Summary

What have we learned?

- AMF is a flexible way to describe the processing pipeline for a piece of media
 - See the AMF spec and Implementation Guide for more info
- Three new OCIO v2 ACES configs will be available soon
 - May be used as a database of transforms for interpreting AMF Transform IDs
- The Academy/ASC Common LUT Format is a huge improvement over previous formats
- OpenColorIO v2 is a free, high-quality, real-time, open source ACES implementation

A 3D rendering of a transparent cube with a metallic frame, positioned on the left side of the image. The cube is tilted, and its edges are highlighted with a golden glow.

Thank you!

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