Overview of the Image Interchange Framework

October, 2008

Academy of Motion Picture Arts and Sciences

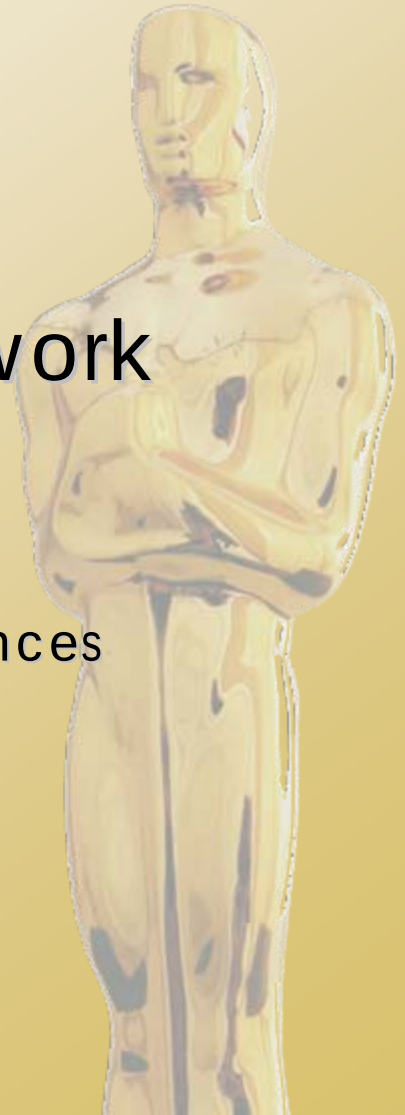

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Image Interchange Framework

- Science and Technology Council
- Advanced Technology Projects
- Image Interchange Framework
  - 4 years
  - 50 members
  - Current Status

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Session Overview

- Why
- What
- Design Principles
- Architecture
  - Color space and encoding
  - Input and output
- Tests
- Standards
- Production readiness?

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Motivation

35mm film has been
the standard interchange
for motion picture workflows for 70 years

Need a new
'Digital Source Master'

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Why

- Wide gamut displays
- High dynamic range imaging
- Increased precision
- Mixed media production
- 4K and greater pipelines
- Multiple distribution formats (film, digital files, HDTV, etc.)

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Why

The Future is Here

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Requirements for DSM

- The ‘source’ image essence
- Handle images from multiple input media
- Best quality, finished version
- Highest finished resolution
- Largest color space
- Multi-purpose, multi-format outputs
- Device Independent

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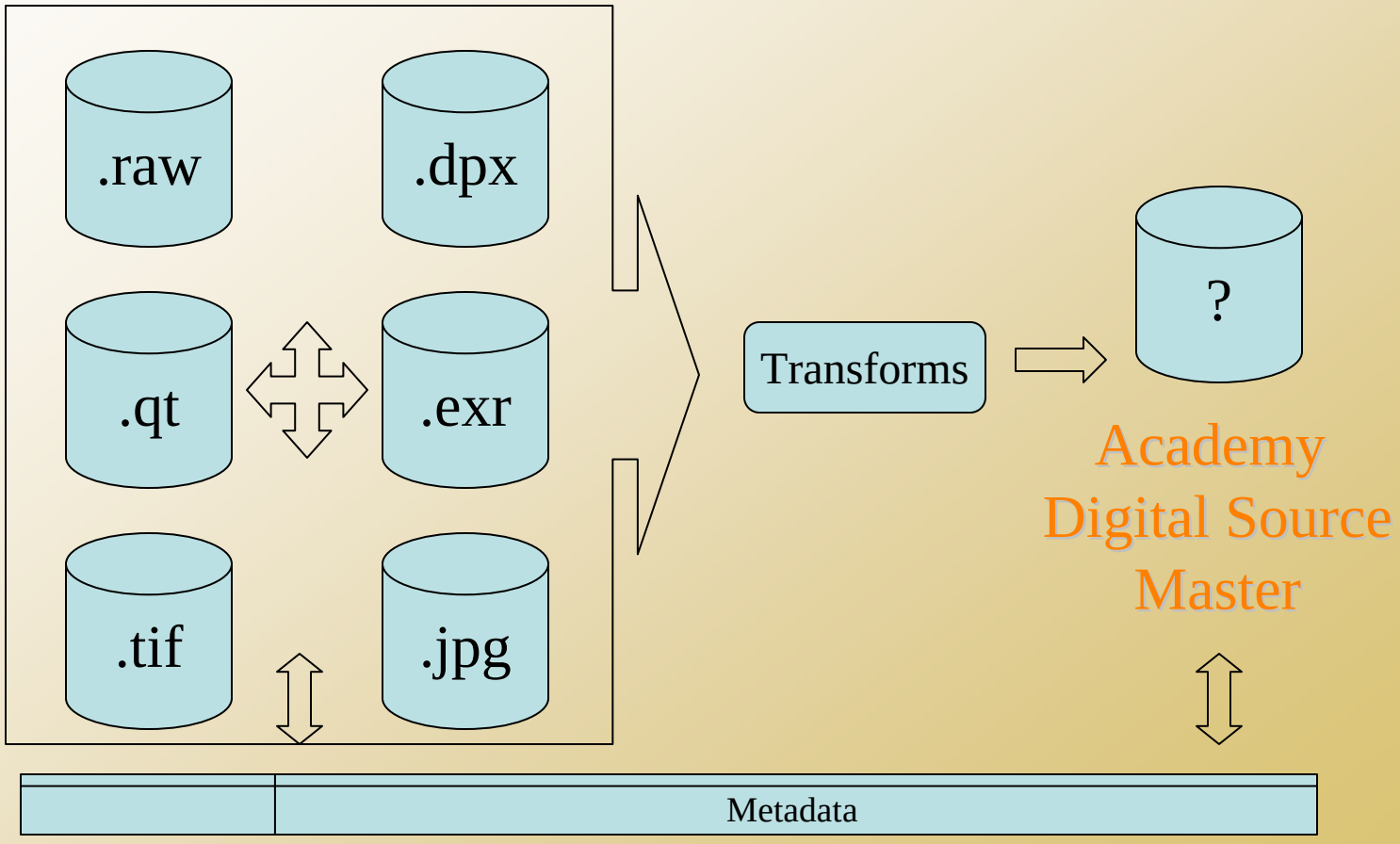
Why a Framework?



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Goals

- Merge digital-sourced and film-sourced material
- Eliminate image conversion errors
- Preserve cinematographer intent
- Provide improved color management within pipelines and across facilities
- Archival digital master

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Academy Digital Source Master

- Destination format for
  - color correctors
  - digital cameras
  - renderers
  - scanners
  - telecines

Usable in as many parts of the digital workflow as possible, but allows facilities to keep using their own pipeline

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Academy Digital Source Master

A common studio master for

deliverables
facility interchange
archiving

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Academy Digital Source Master

Image files

- Image Container

  Minimal metadata

Metadata files

- XML containers for common metadata

  (shot, reel, show levels)

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Design Principles

Interoperation of Images from Film, Digital MP Cameras, and CGI

- Color Accuracy (Scanned results are different from different scanners – this is a problem today)

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Design Principles

Simplify Image Conversions

Provide fixed transforms for common uses

Averaged and ‘universal’ conversions

Design Principles

Colorimetric specification

Each code value maps to a specific color

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What do the color values mean?

What is the common ground for photographic systems?

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Colors in the Scene

Scene

Film Negative

Digital MP Cameras

Stills Cameras

Encoded Color

Dailies

VFX

Look Mgmt

CGI

D.I.

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Design Principles

Colors from scene exposures

Conversions based on the color response of capture media

But...

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Design Principles

Colors from scene exposures

But… will always have some inaccuracy because there is no perfect capture technology

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Design Principles

A human viewer is always in the loop

Color fixes … by eye… for a device

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Design Principles

Linear Light

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Design Principles

All possible colors

Cover the visible gamut

Use RGB primaries

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Design Principles

High dynamic range

>20 stops of range (1,000,000:1)

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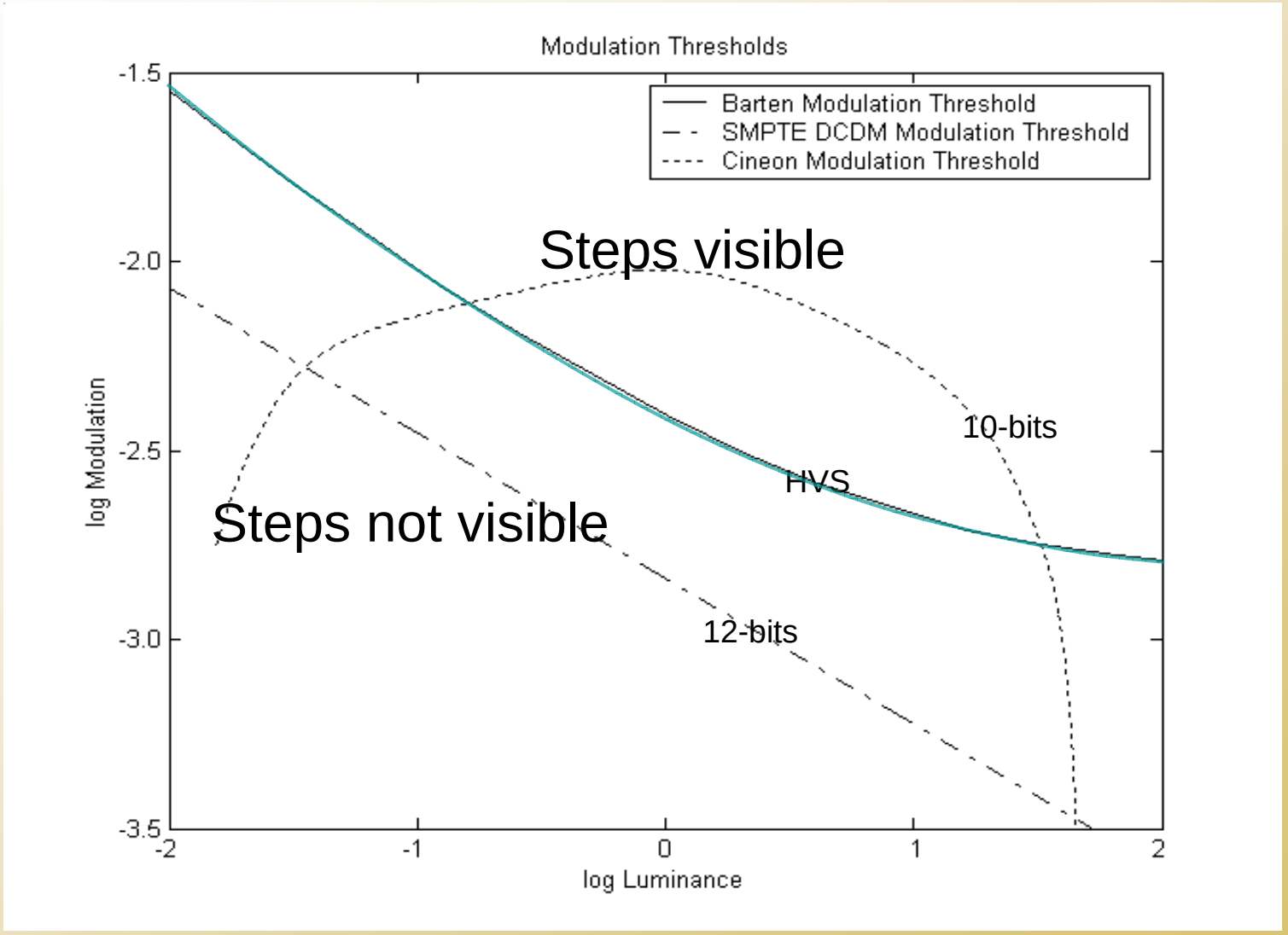
Design Principles

Floating point color

Improved step to step precision

Integer Worries



Graph by Thomas Maier, Eastman Kodak

Design Principles

Analogy to Negative Film/Positive Film

Separate input and output image needs

Color Rendering

Linear

Rendered with film-like tone curve

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Architecture

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Architecture

Color Space

ACES

Academy Color Encoding Specification

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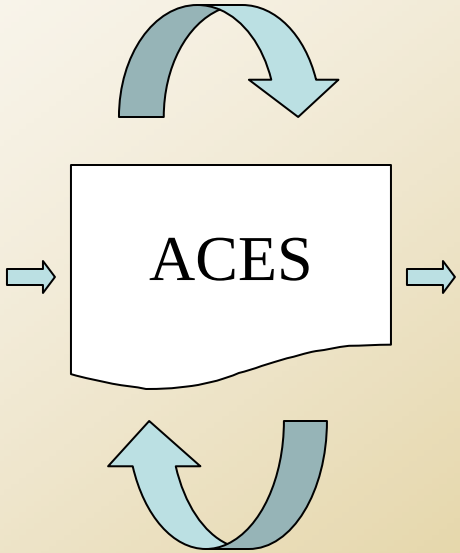
Reference Design System



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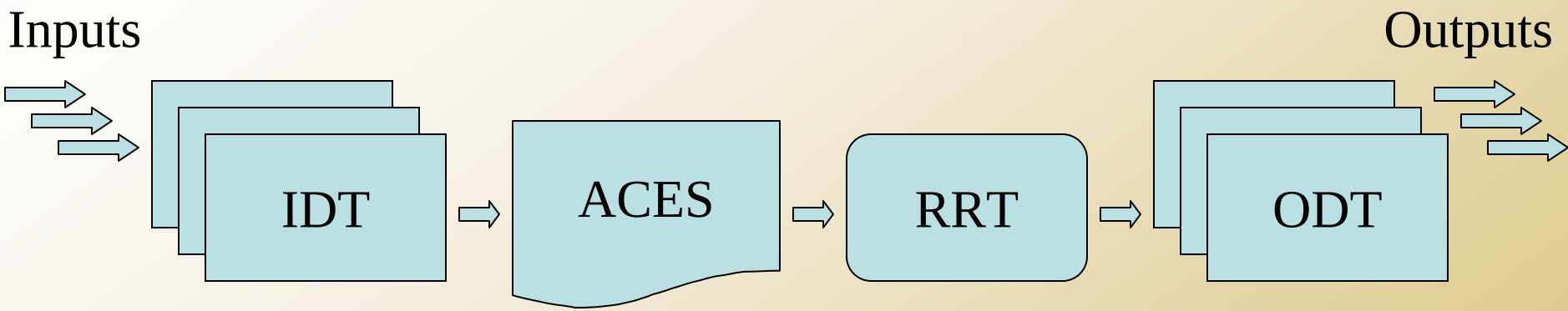
Framework Architecture Components



IDT - Input Device Transform

ACES - Academy Color Encoding Space

RRT - Reference Rendering Transform

ODT - Output Device Transform

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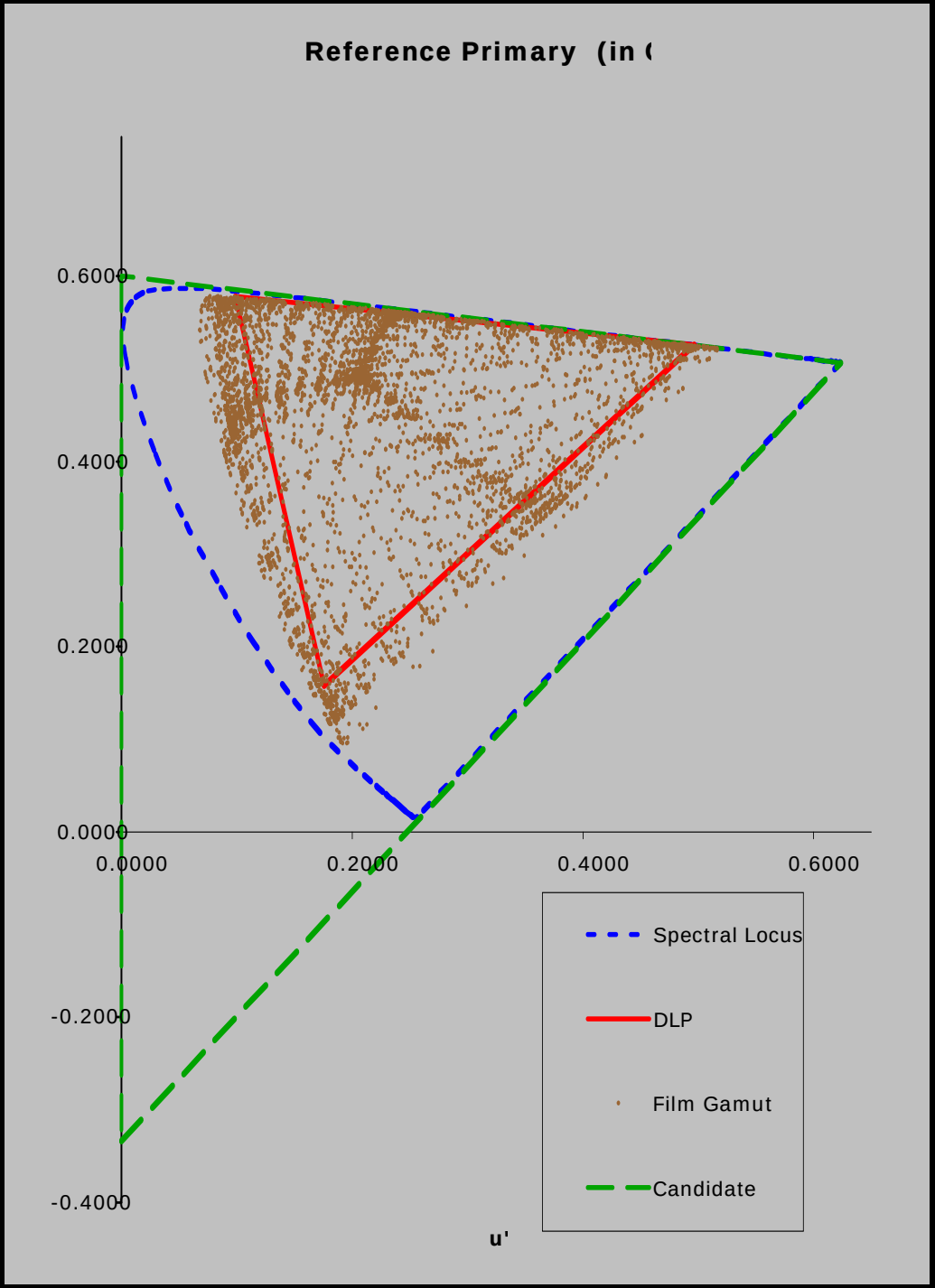
Academy Color Encoding Specification

Specification:

- Fixed RGB reference primaries
- 16-bit half-floats
  - Range from (-65504.0 to +65504.0)
  - Set black = 0.0, then 0.000000059 is lowest light level
  - Negative values are valid codes.

{ 0.14, 1.00, -0.55 }

ACES Color Space



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Academy Color Encoding Specification

Encoding Specification:

- Define Black as {0.0 0.0 0.0}
- Define midpoint 'grey' reference as {0.18 0.18 0.18}

  Digital LAD point

  in XYZ = {0.1719, 0.1800, 0.1854}
- Define neutral axis as (x=0.320 , y=0.355) for transform calculations

Provisional -- subject to change

Image Container: the .aces file

Constrained version of OpenEXR format

Accessed through OpenEXR API

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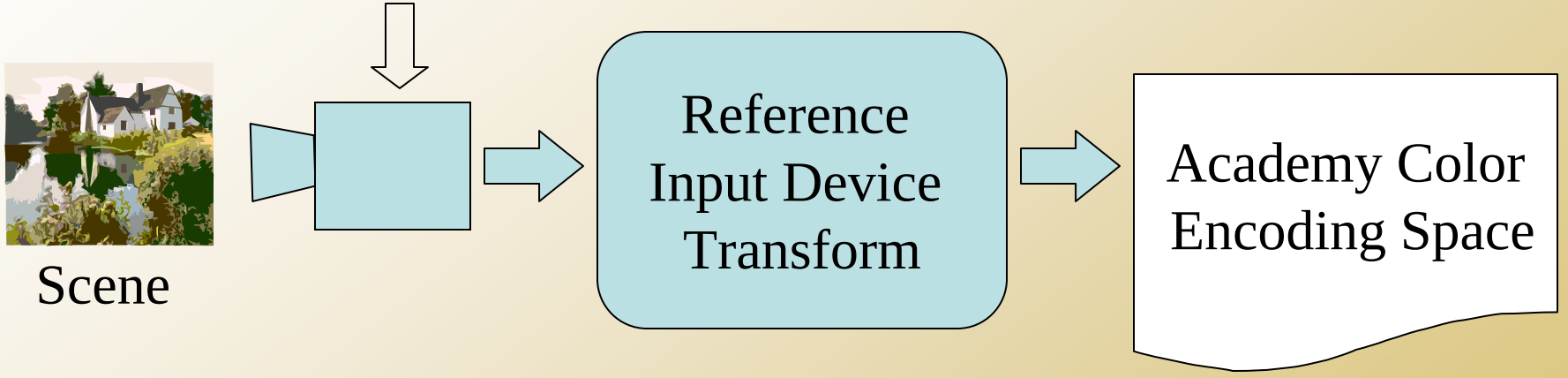
Input Methodology



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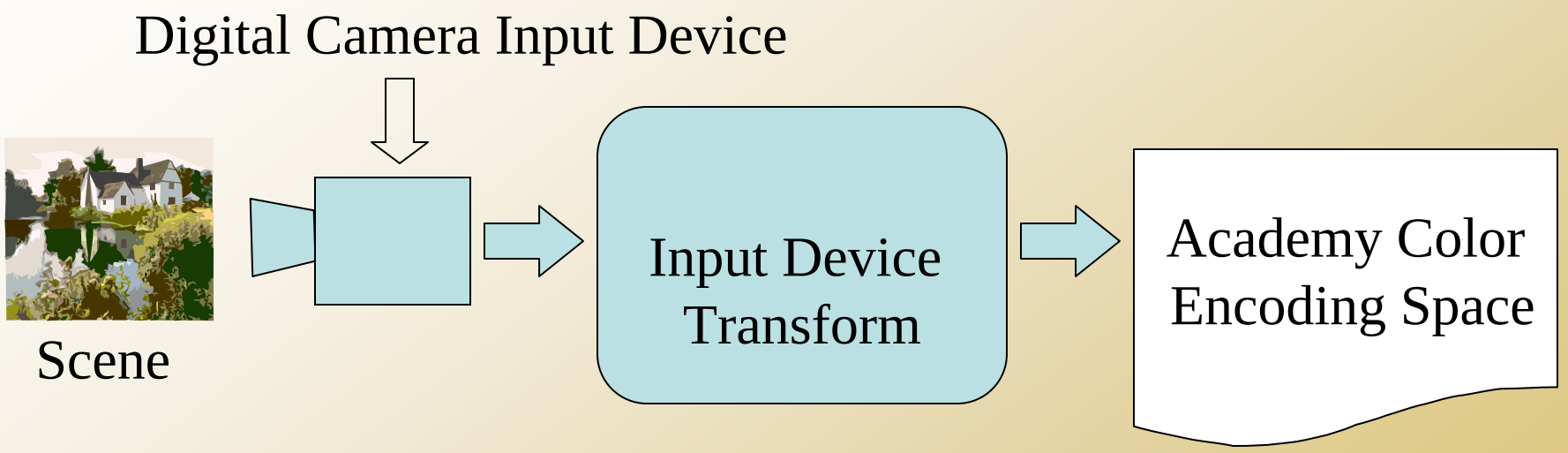
Input Methodology: Digital



Characterize Digital Camera to determine transform

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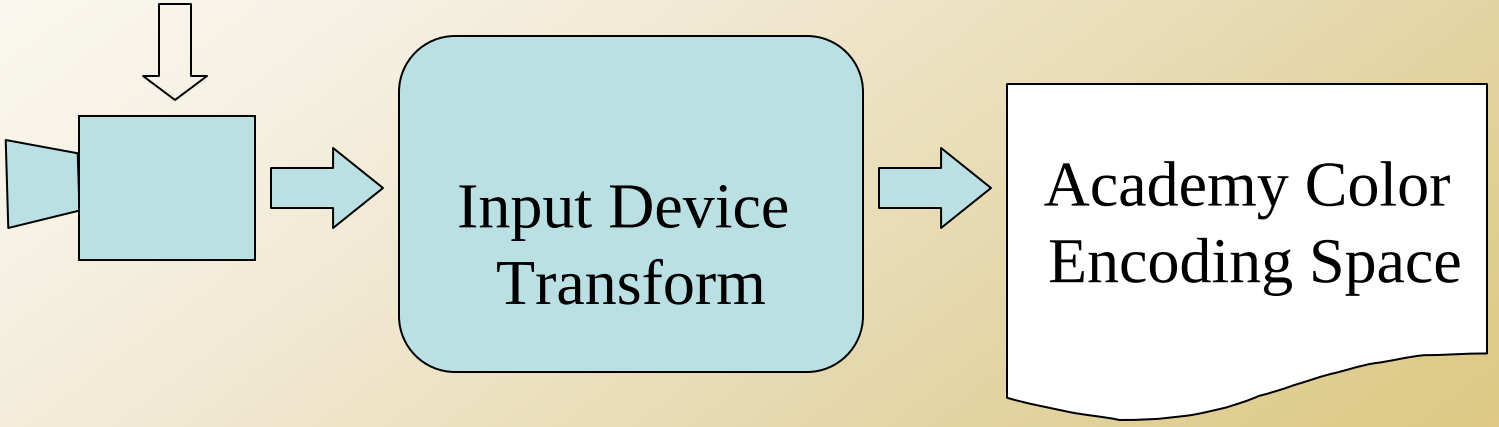
Input Methodology: Film

Film Negative to Film Scanner Input Device

Scene



Calibrate scanner and apply transform from film characteristics

COLOR SPACE

APD

Academy Printing Density

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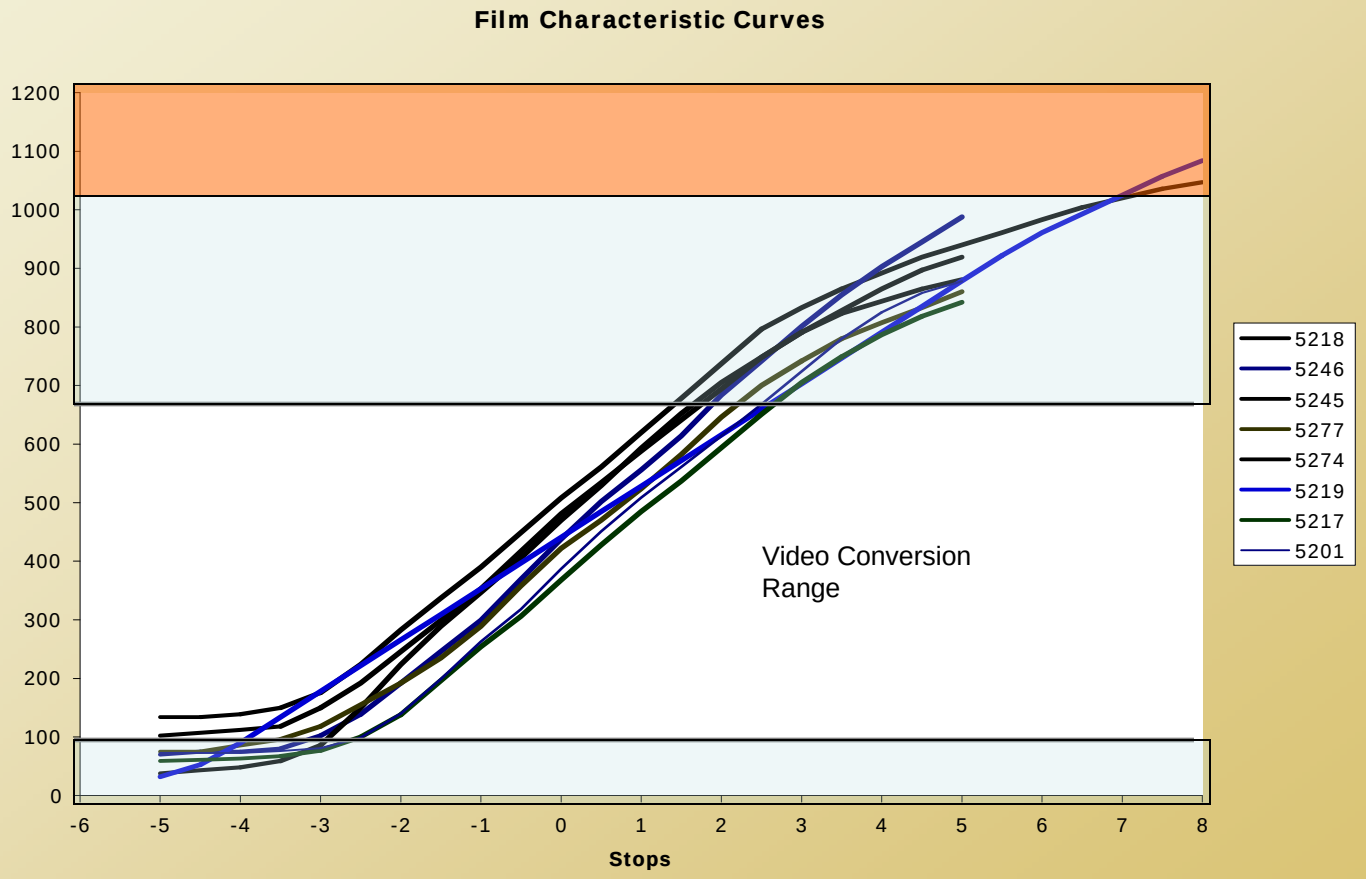
Input Methodology

Printing Density

How a film print ‘sees’ the light that comes through a negative from a printer lamphouse

Contrast Range of Film Negatives



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Input Methodology

APD proposed as a scanner calibration standard

specifies a ‘spectral condition’

ADX is the encoded form

- define a 10-bit encoding for compatibility
- define a 16-bit integer encoding to handle extended negative ranges

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Input Methodology

Another challenge

getting “Scene Linear” values from film negatives

Unbuilding the film response…

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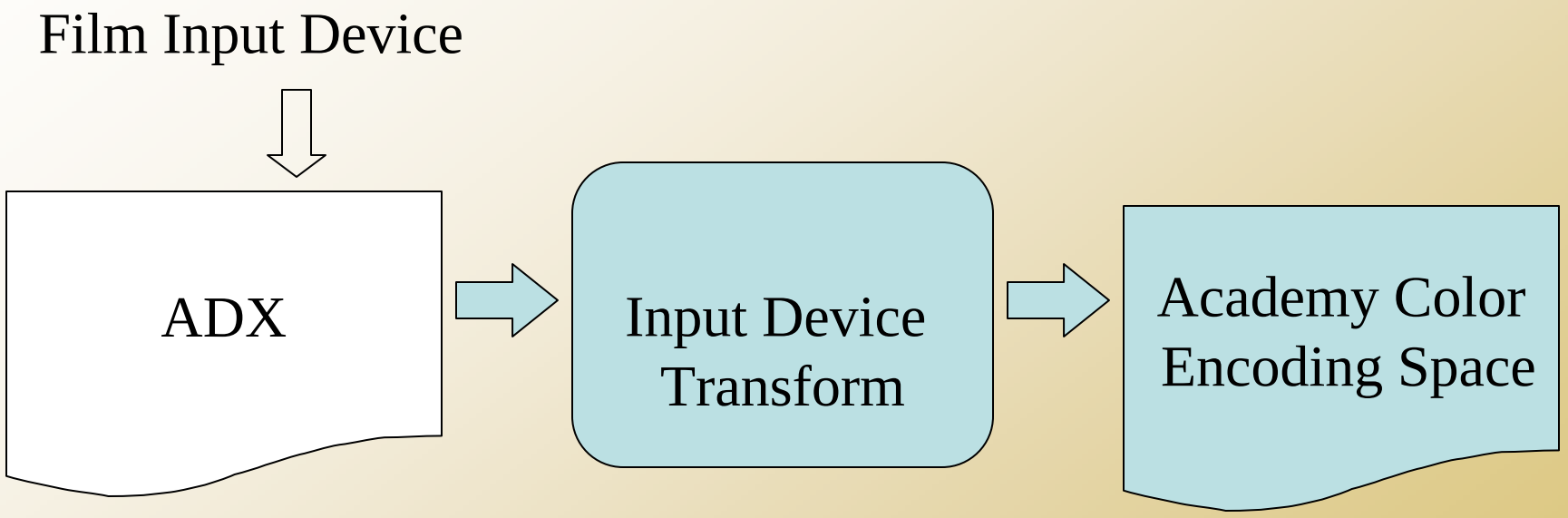
Input Methodology



Tone curve is proportional to scene exposure but exact energy linear light is not assured

We can accept inexactness because we have a WYSIWIG preview stage

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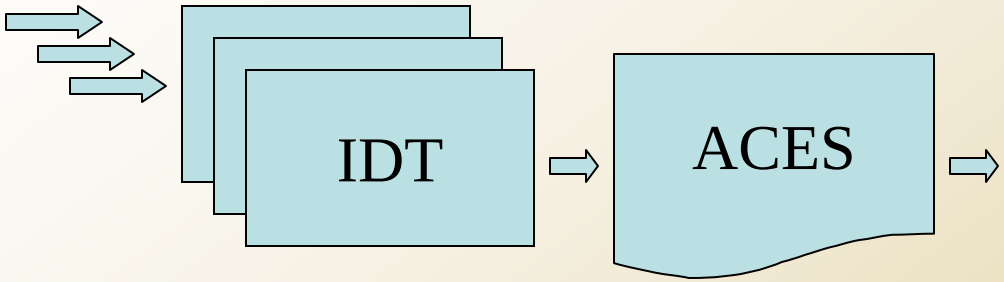
Reference Design System

Inputs



IDT - Input Device Transform

ACES - Academy Color Encoding Space

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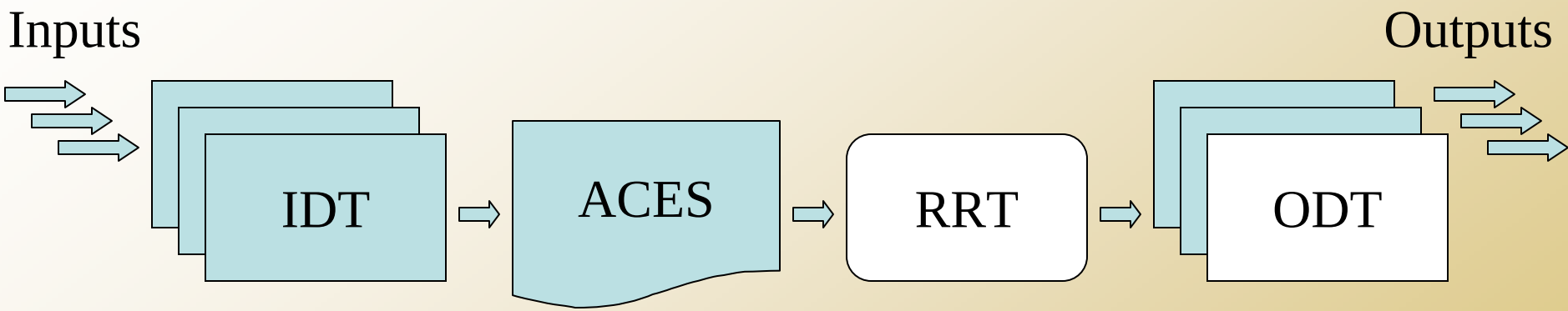
Reference Design System



RRT - Reference Rendering Transform

ODT - Output Device Transform

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Virtual Print Stock

Need an output color rendering transform

The Reference Rendering Transform (RRT)

Allows archival reference to exact color

Color Rendering

Linear

Rendered with film-like tone curve

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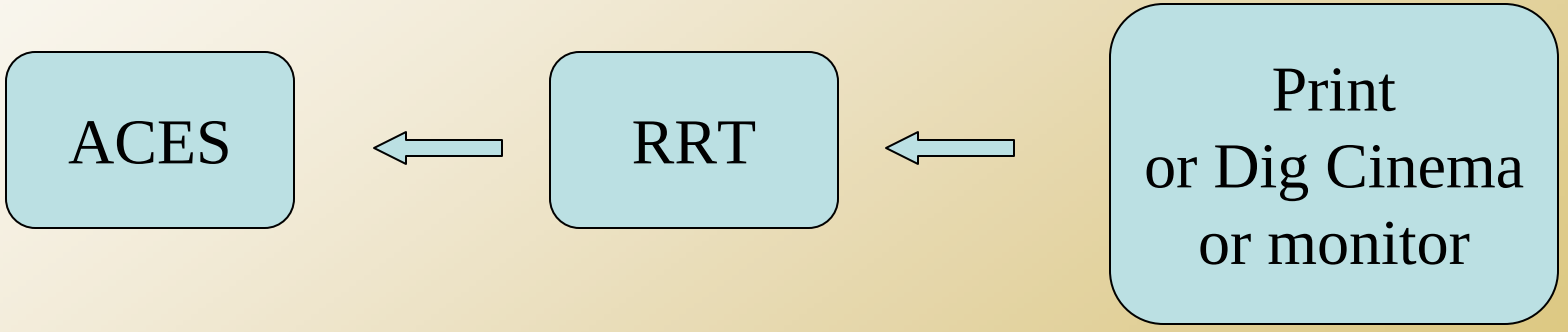
Archival Color Reference



Standard
Color Space

Creative Intent
Color

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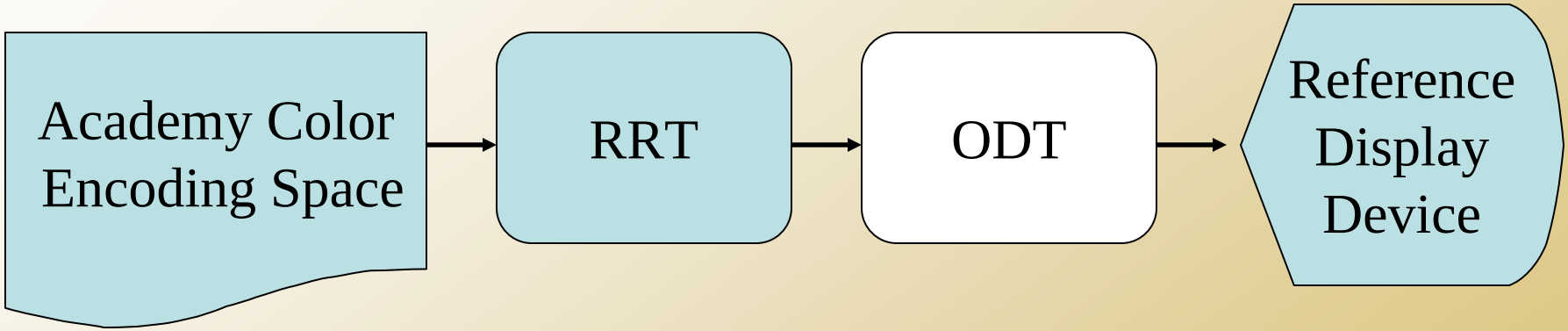
Output Methodology



ODT - Output Device Transform

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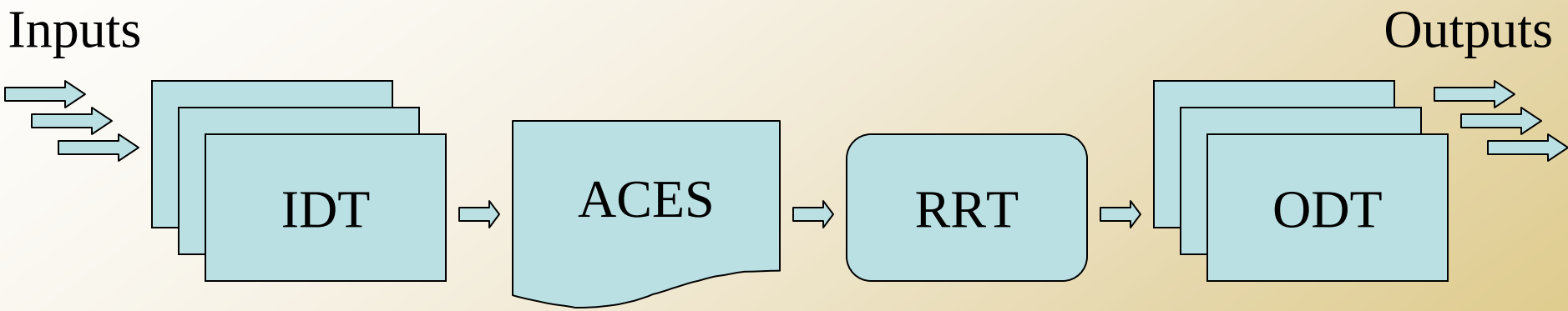
Framework Architecture Components



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Testing

- APD spec and encoding validation
- ADX to ACES conversion IDT
- Reference Image Library development
- Digital Camera IDT development
- RRT specification and development
- Container and Metadata

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Testing - Software implementation

- Application software
  - implement architecture with color transforms or,
  - use application plug-ins and nodes (Shake nodes, After Effects plug-ins) or,
  - use 3DLUTs or,
  - CTL utility programs
- Libraries
  - OpenEXR libraries
  - Color Transformation Language (CTL)

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Standards interaction

- Upcoming SMPTE work
- Specifications
  - ACES, APD, RRT
- Recommended practices for
  - film scanning and scanner calibration film
  - digital camera characterization and input transforms
  - film recording targets

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Committee work

- Standard transforms
  - For most common color space transforms
    - ADX to ACES
    - Rec709 to ACES
    - RRT/ODT for Digital Cinema
    - RRT/ODT to APD printing negatives
- Software reference implementation
- Common LUT format

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Summary

Standardized color spaces for ACES and APD with fixed transforms reduces conversion errors, improves color management, and still allows custom workflows

Multi-facility workflows are improved with a well-defined Image Framework

Framework allows for future growth and new technology on the horizon

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Image Interchange Framework

Visit www.stcatp.org