OpenColorIO

Open Source Color Pipeline

Jeremy Selan
Sony Pictures Imageworks


SONY PICTURES
imageworks

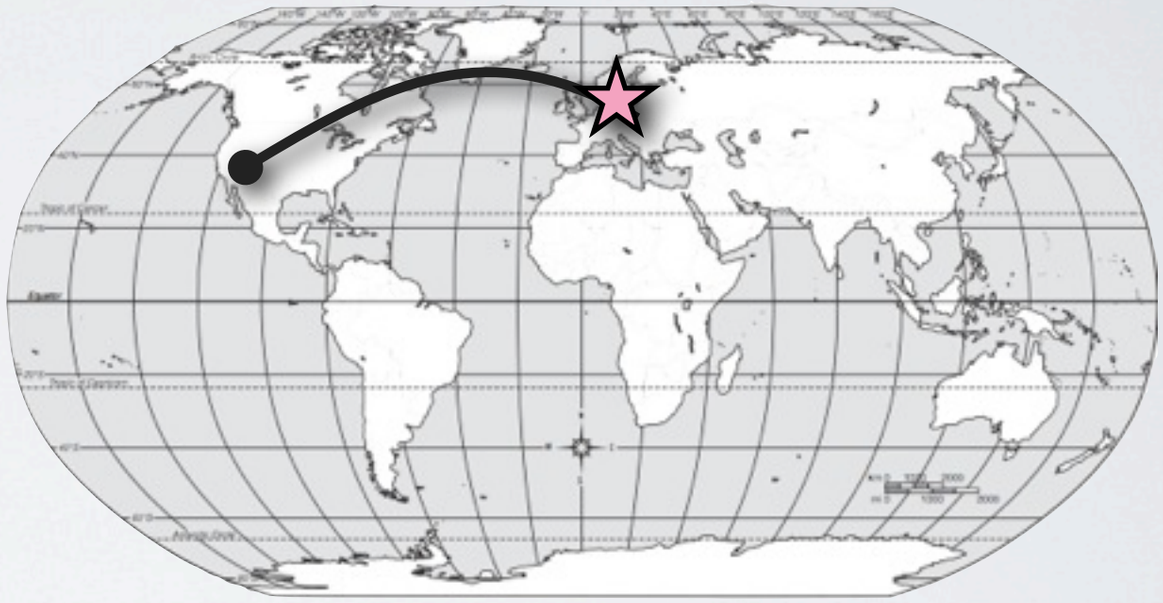
About Myself

Sony Pictures Imageworks

OpenColorIO

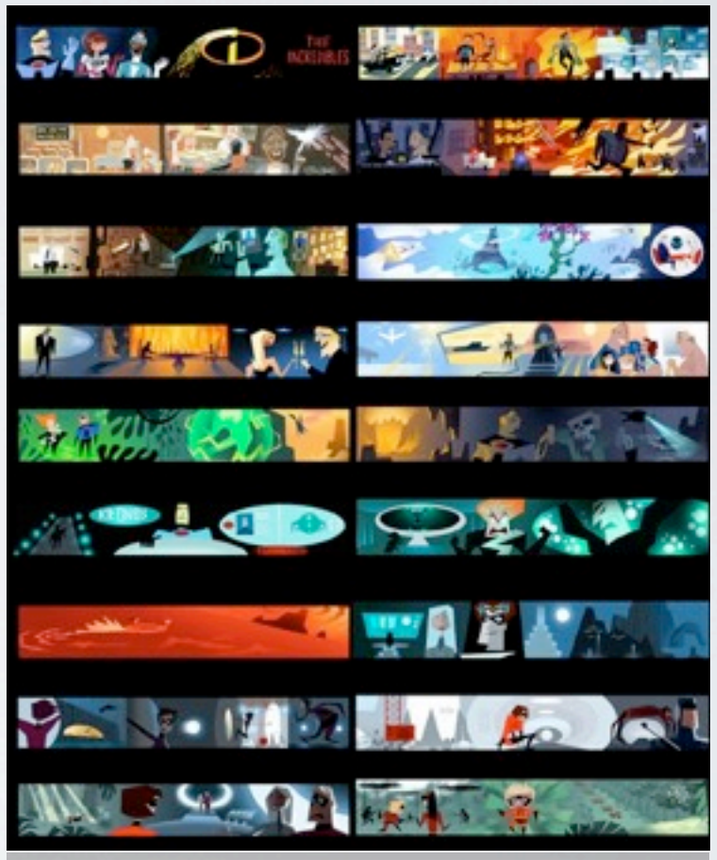
Katana

IIF / ACES



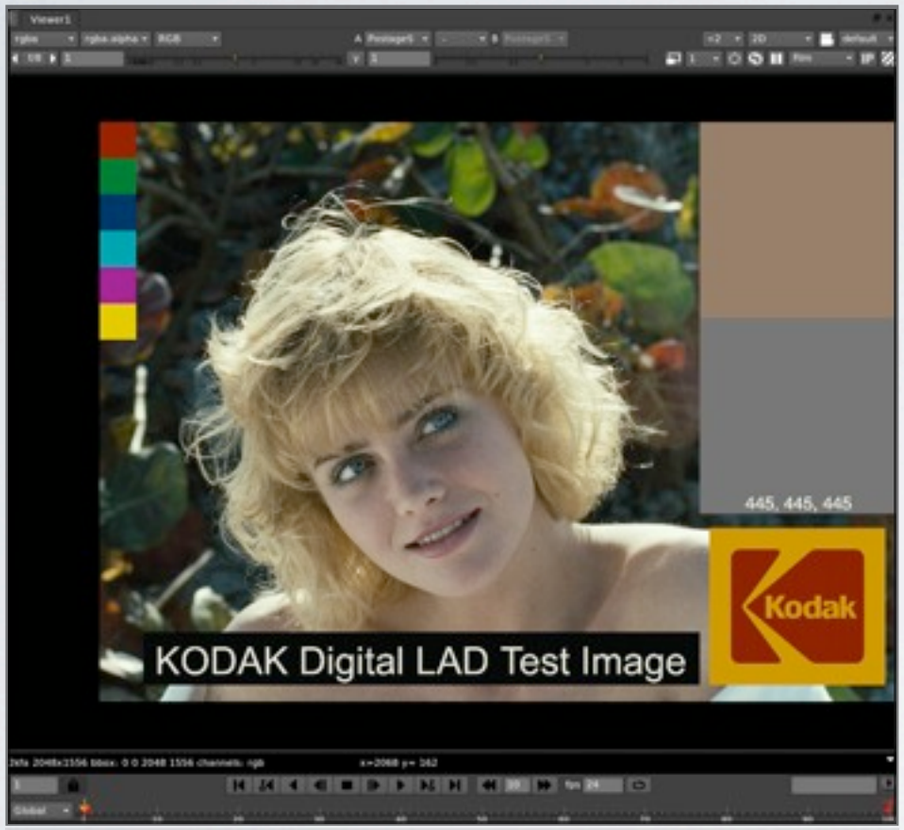
What makes color management hard?

- Context-Driven Requirements
  (Animation / VFX / Film / TV)
- Many schools of thought
- Varied Client Requirements
- Complex Software Ecosystem

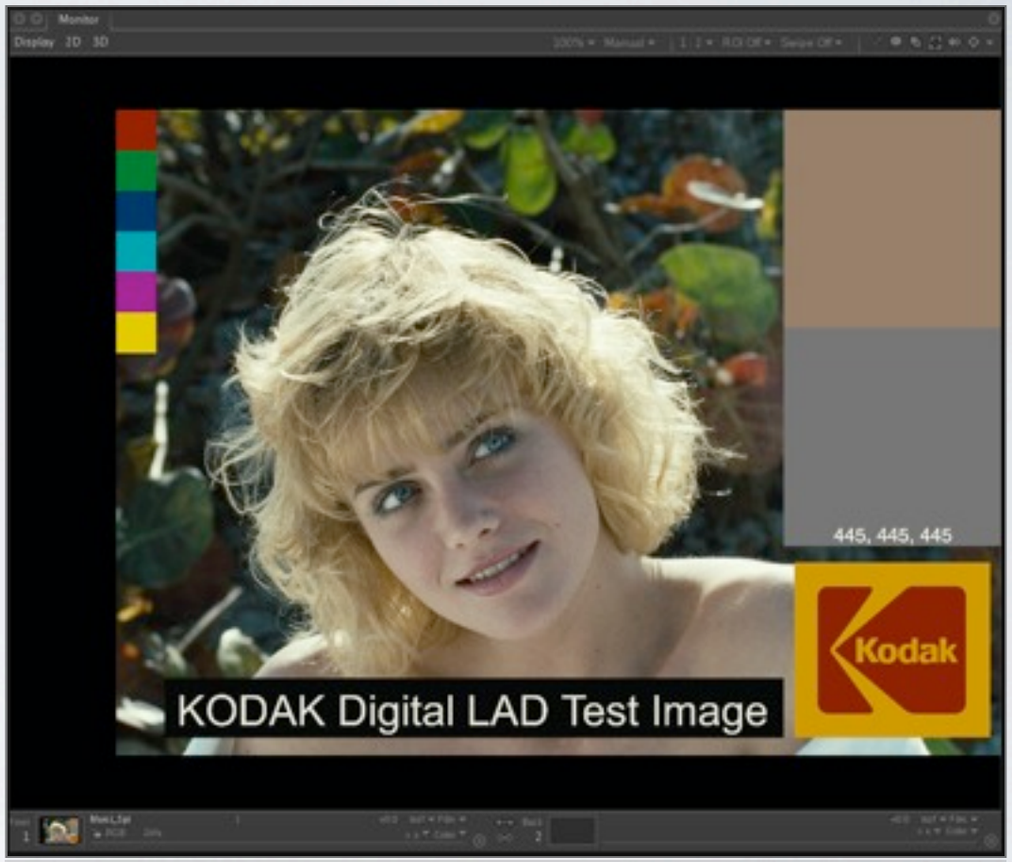


OpenColorIO Motivation

- Consistent Image Display
- Consistent Color Transforms


Viewer1
445, 445, 445
KODAK Digital LAD Test Image
Kodak

Nuke

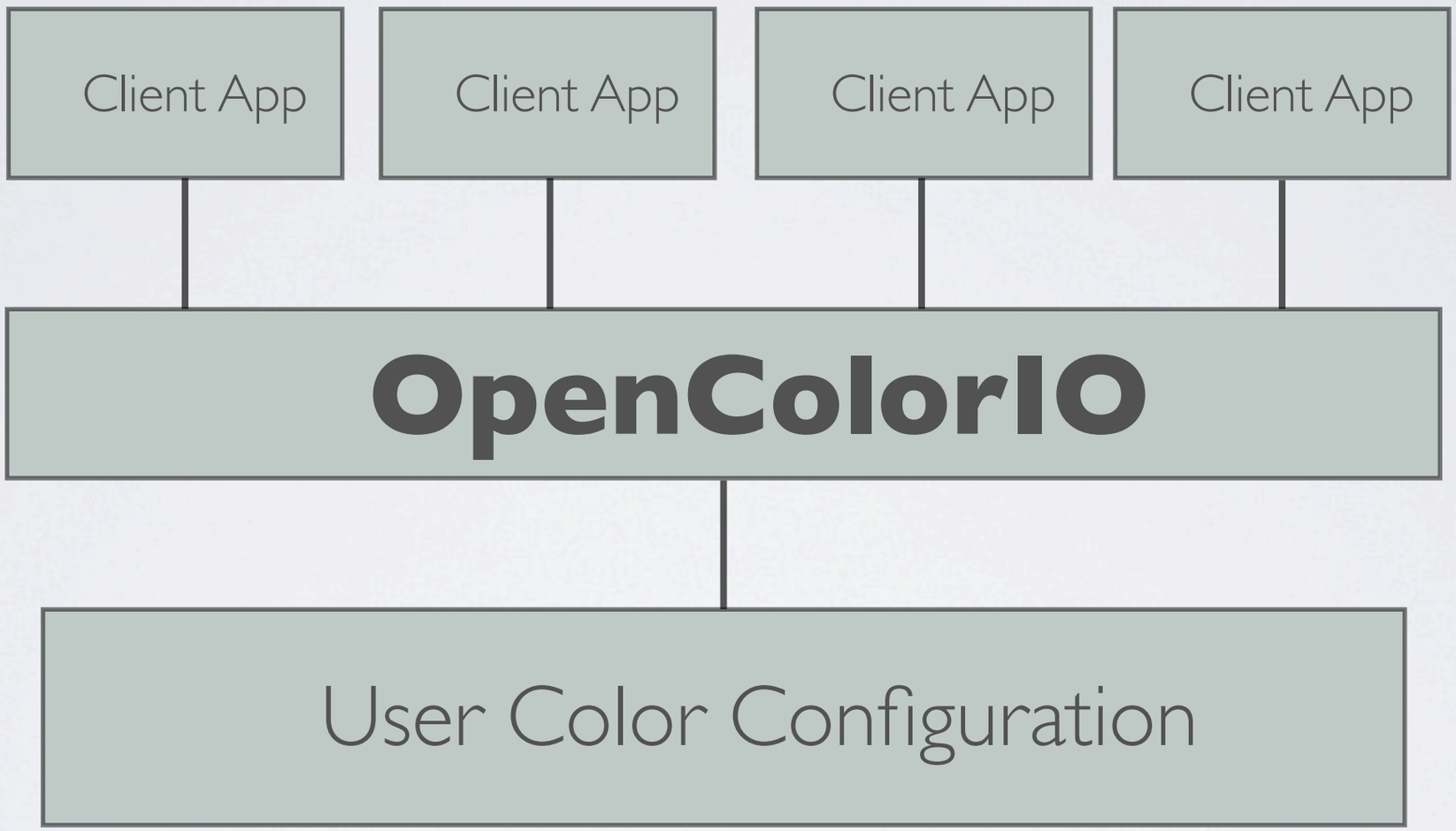

Monitor
Display 2D 3D
445, 445, 445
KODAK Digital LAD Test Image
Kodak

Katana

OpenColorIO Motivation

- Roots in visual effects
- But... potentially useful across full digital motion picture workflow

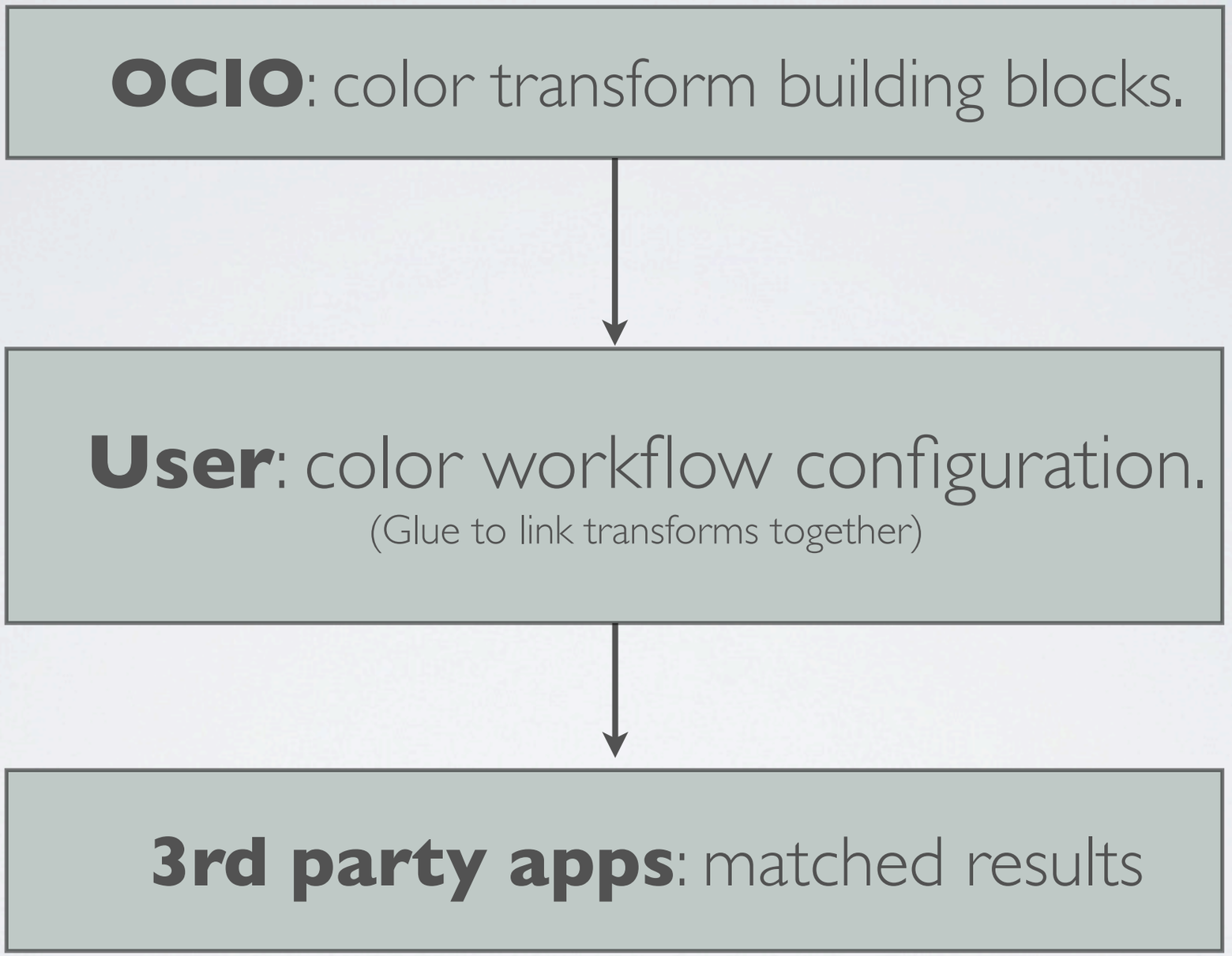
System Architecture



OpenColorIO: Batteries Included

- Core Library (C++)
- Example ‘real world’ color workflows
  (including IIF)
- Plugins for 3rd party apps
- Command-Line tools
- Multi-Platform: *(Linux, OSX, Windows)*

Workflow

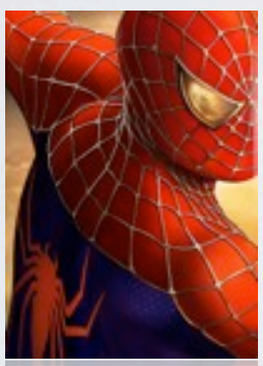

OCIO: color transform building blocks.
User: color workflow configuration.
(Glue to link transforms together)
3rd party apps: matched results

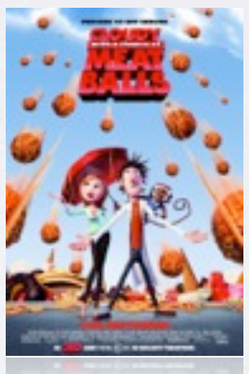
History

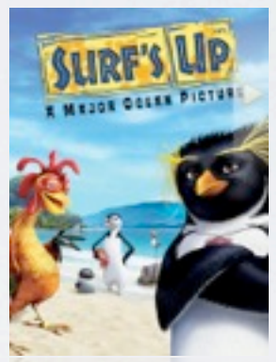
Started in 2003 at Sony Imageworks

Supports user-defined color workflows: vfx, anim, iif

Already used on dozens of motion pictures:





OCIO Details

OCIO::**Transform**

- Common LUT formats / flavors
- Simple Math: *(ASC-CDL, matrix, gamma, log, exponent, ...)*
- ICC Export *(LittleCMS)*
- Truelight Compatibility *(Optional at compile time)*

Additional transforms will be added as needed.

OCIO::**Config**

- Provided at runtime, *$OCIO* environment variable
- Defines *all* color conversions client apps may use
- Provides named ColorSpace
- Defines output display devices

OCIO::**Config**

(free at opencolorio.org)

- VFX Config
- Animation Config
- IIF Config
- Nuke-default

OCIO Image Processing

- CPU / GPU Support
- Native f32 color processing
- Native HDR Support
  (explicit dynamic range allocation control)
- Per-Shot LUT / Look Support

OCIO 3rd Party Support

Native Integration

- Nuke 6.5
- Katana 1.0
- Mari 1.3
- Silhouette
- OpenImageIO
- Python

Export Compatibility

- Autodesk Apps (Flame, Lustre)
- Photoshop (ICC)
- Houdini (HDL)
- Most color correctors (all other apps which read 3DL, CSP, ICC)

More, coming soon.

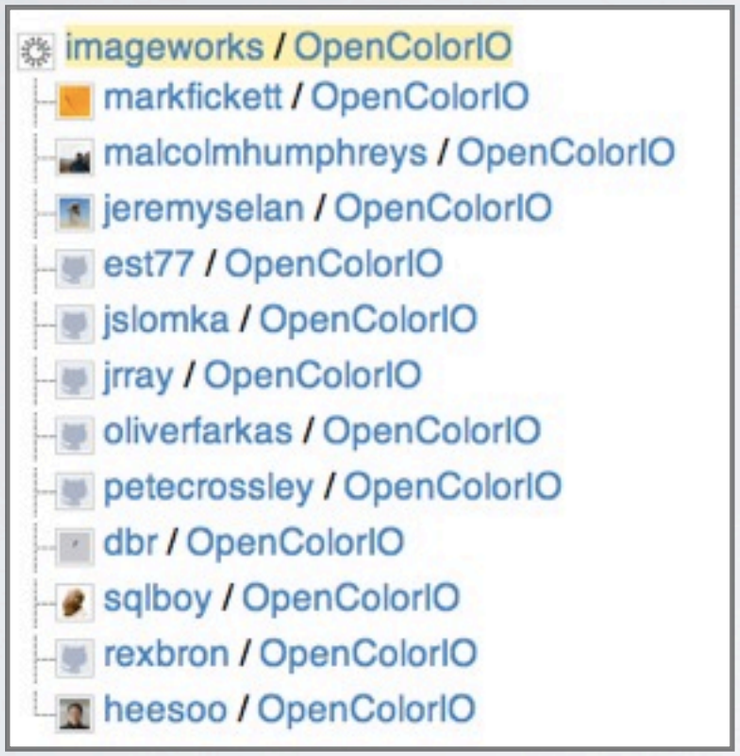
OCIO 3rd Party Support

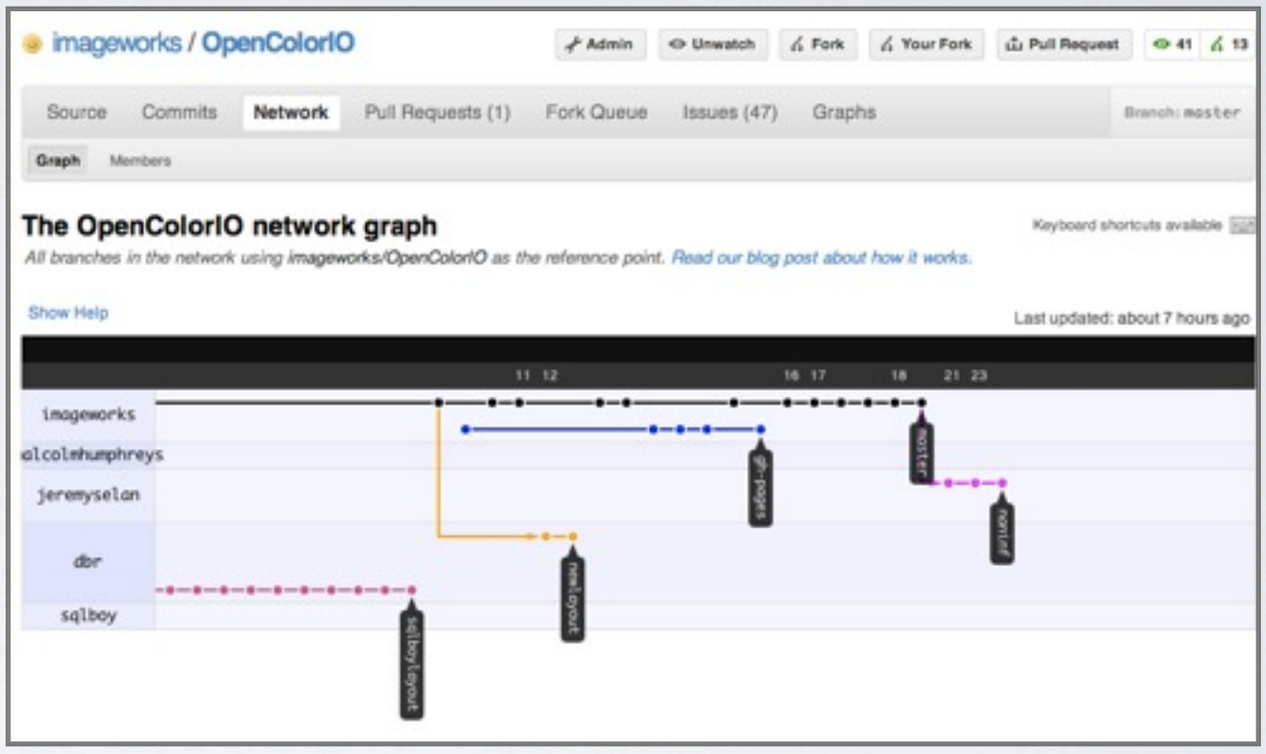
In discussions with hardware vendors about on-set integration.

Open Source Development Process

Github

Github Contributors





On Being Naked

- We really do our development in public
  (checkins, code reviews, discussions, issues)
- We've made some embarrassing mistakes
- Integrity, not fear
- Airing dirty laundry breeds trust amongst community

Top OpenColorIO Issues

Need Better App Support
(Maya, RV, Houdini)

Documentation Lacking

Installation is complex

Currently tailored to large facilities
(display profiling, etc)

Open Source in Visual Effects

- Large Studios now contributing to Open Source
  (SPI / Disney / Weta / ILM / Double Negative / etc.)

- Notable projects:
  - OpenEXR (1.0 / 2.0)
  - Alembic
  - PTEX
  - OpenImageIO
  - OpenColorIO
  - OpenShadingLanguage (OSL)

For More Info

opencolorio.org

opensource.imageworks.com

Sign up for our public mailing-list!

Acknowledgements

Imageworks

Rob Bredow, Joseph Slomka, Sean Looper

Open Source Contributors

The Foundry, Malcolm Humphreys (DNeg),
Oliver Farkas, Ben Dickson (Rising Sun)

And all of our users!

QUESTIONS? / DEMO

Jeremy Selan
Sony Pictures Imageworks

OpenColorIO

Open Source Color Pipeline

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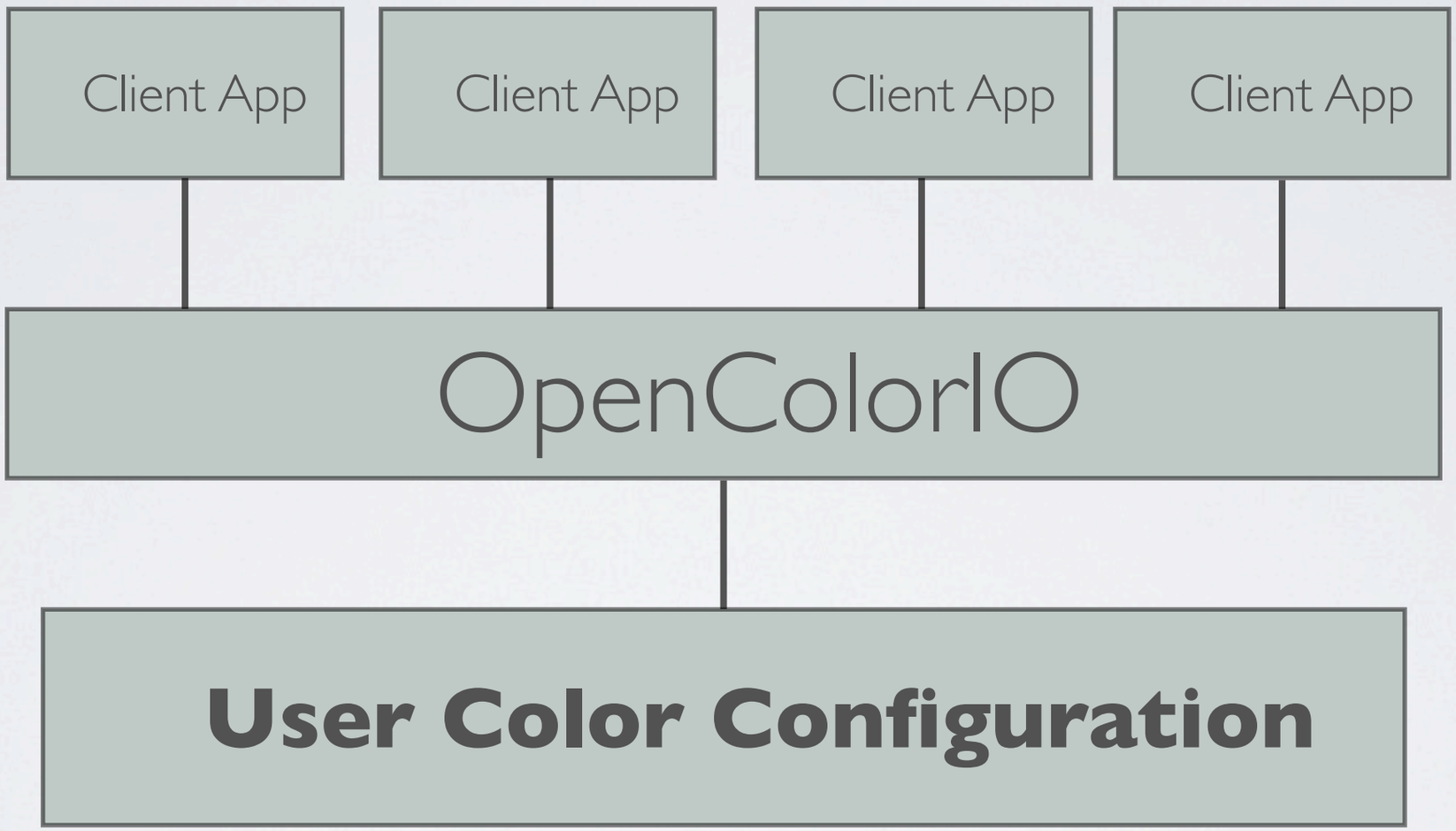
Sony Pictures Imageworks

System Architecture



Color Configurations

$OCIO

(download from: opencolorio.org)

- VFX Config
- Animation Config
- IIF Config
- Nuke-default

Client

Compositing

Client

Rendering

Compositing

Client

Color Pipeline

Textures

Mattes

Rendering

Compositing

Client

Client Delivery

Pick appropriate OCIO config.

(Or, make your own).

Delivery implies color workflow.

- How will images be viewed downstream?
- Will delivery have view lut baked in?
  (Hopefully, not)

Image Display

Identify your reference ‘gold standard’ display.

- All apps must be judged validated relative to this environment (or not used for color judgements)
- Apps must take image color space into account
- Display transform is device-specific (after calibration

Color Configurations

$OCIO

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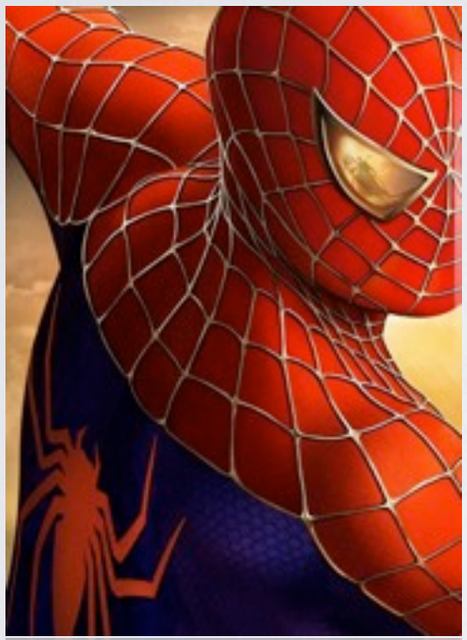
VFX Color Config

End to end process **must** be no-op.

Input / Output plate conversions are simple (1D) and perfectly invertible.

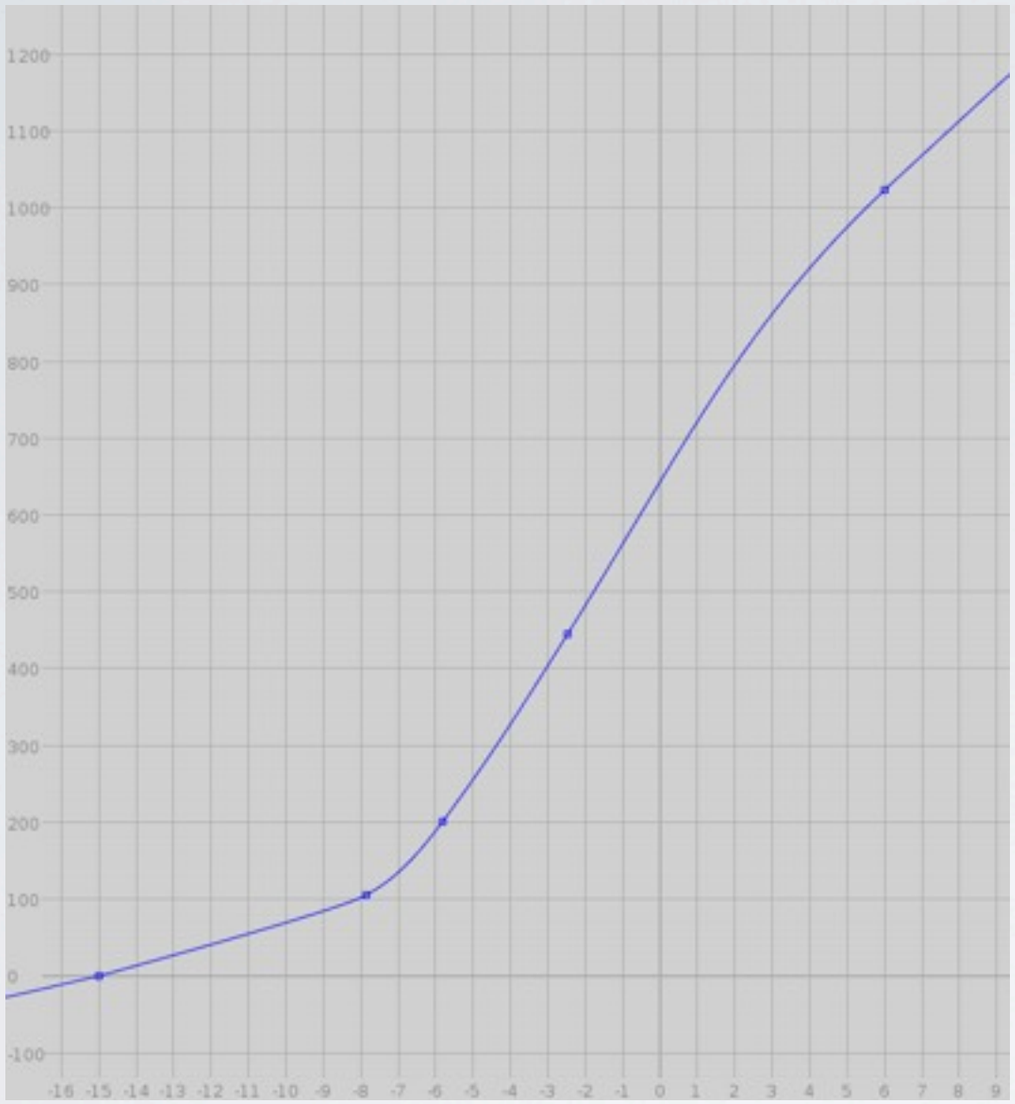
Image visualization does heavy lifting (3D)

VFX Color Config



Linear working space is High dynamic range, scene referred.

Middle gray at 0.18. Most pixel values -8 to +8 stops



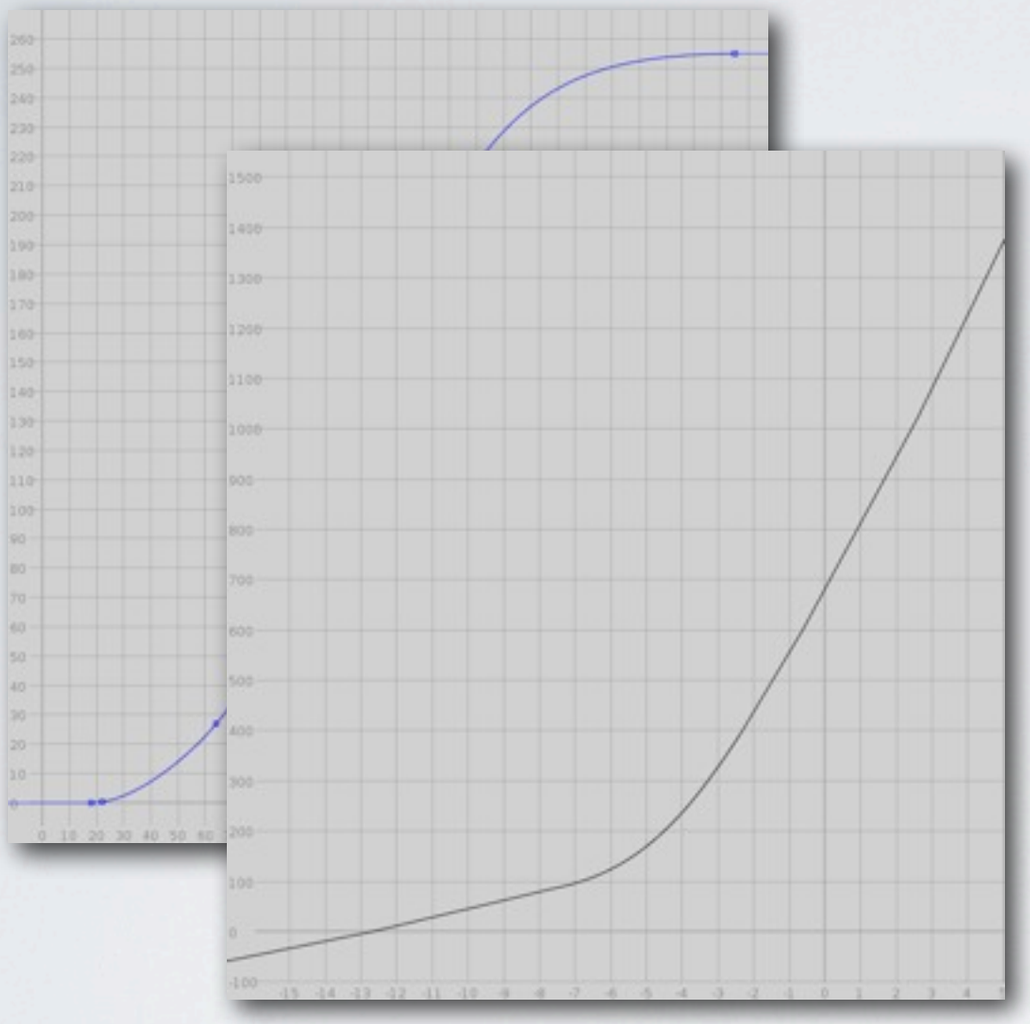
Film scan linearization based on ‘generic’ acquisition stock.

Middle gray at 0.18 (445)

~ 78 code values / stop in linear portion

Toe at -5.5 stops (under gray)

Shoulder at +7 stops (over gray)



Genesis Log

RED Cinelog

sRGB

DLP P3

XYZ (DCDM)

Animation Color Config

1-D approximation of filmic tone rendering

High dynamic range linear

Output Referred (Rec. 709 Primaries)

Conversion to display (DLP/sRGB) is simple (1D/MTX)

opencolorio.org /downloads

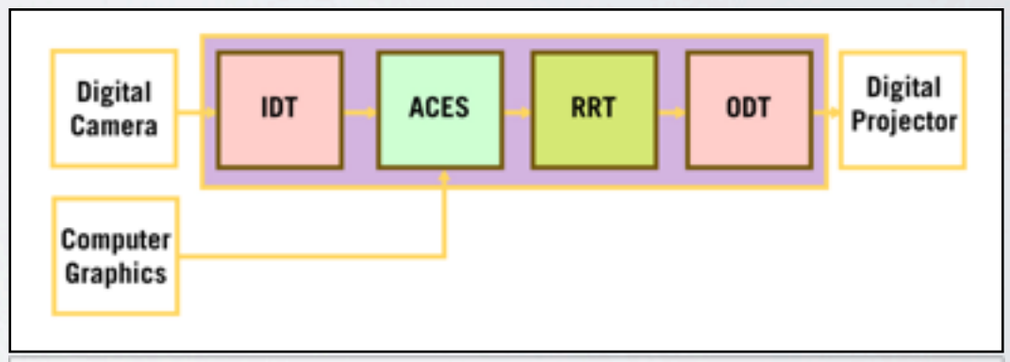
opencolorio.org /downloads

ACES (IIF) Color Config

- Created by AMPAS
- Standardized EXR space (ACES)
- Currently in Beta

ACES (IIF) Color Config

- Standardized viewing transform (RRT)
- **ColorSpace**(s) defined for common input devices
- Does not run CTL live



http://www.fxguide.com/featured/the-art-of-digital-color/

OCIO::**Config** Internals

```
colorspaces:
  - !<ColorSpace>
    name: lnf
    bitdepth: 32f
    allocation: lg2
    allocationvars: [-15, 6]

  - !<ColorSpace>
    name: lg10
    bitdepth: 10ui
    allocation: uniform
    allocationvars: [0, 1]
    to_reference: !<FileTransform> {src: lg10.csp}
```

OCIO::**Config** Internals

```
roles:
  compositing_log: lgf
  scene_linear: lnf

displays:
  sRGB:
    - !<View> {name: Film, cs: srgb10}
    - !<View> {name: Raw,  cs: nc10}
    - !<View> {name: Log,  cs: lg10}
  DCIP3:
    - !<View> {name: Film, cs: dlprgb10}
    - !<View> {name: Raw,  cs: nc10}
    - !<View> {name: Log,  cs: lg10}
```

OCIO::**Config** Internals

```
roles:
  compositing_log: lgf
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displays:
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    - !<View> {name: Raw,  cs: nc10}
    - !<View> {name: Log,  cs: lg10}
```

YOUR LUT(S) HERE

Rendering

Inf (HDR scene-linear, float)

Linear in / Linear out.
(shading / illumination in linear)

OpenEXR out (16 vs 32bit)

Ideally, no color space
conversions at render-time

Rendering

Inf (HDR scene-linear, float)

2 common approaches to linear:

Linearized output-referred (gamma 2.2, etc.)

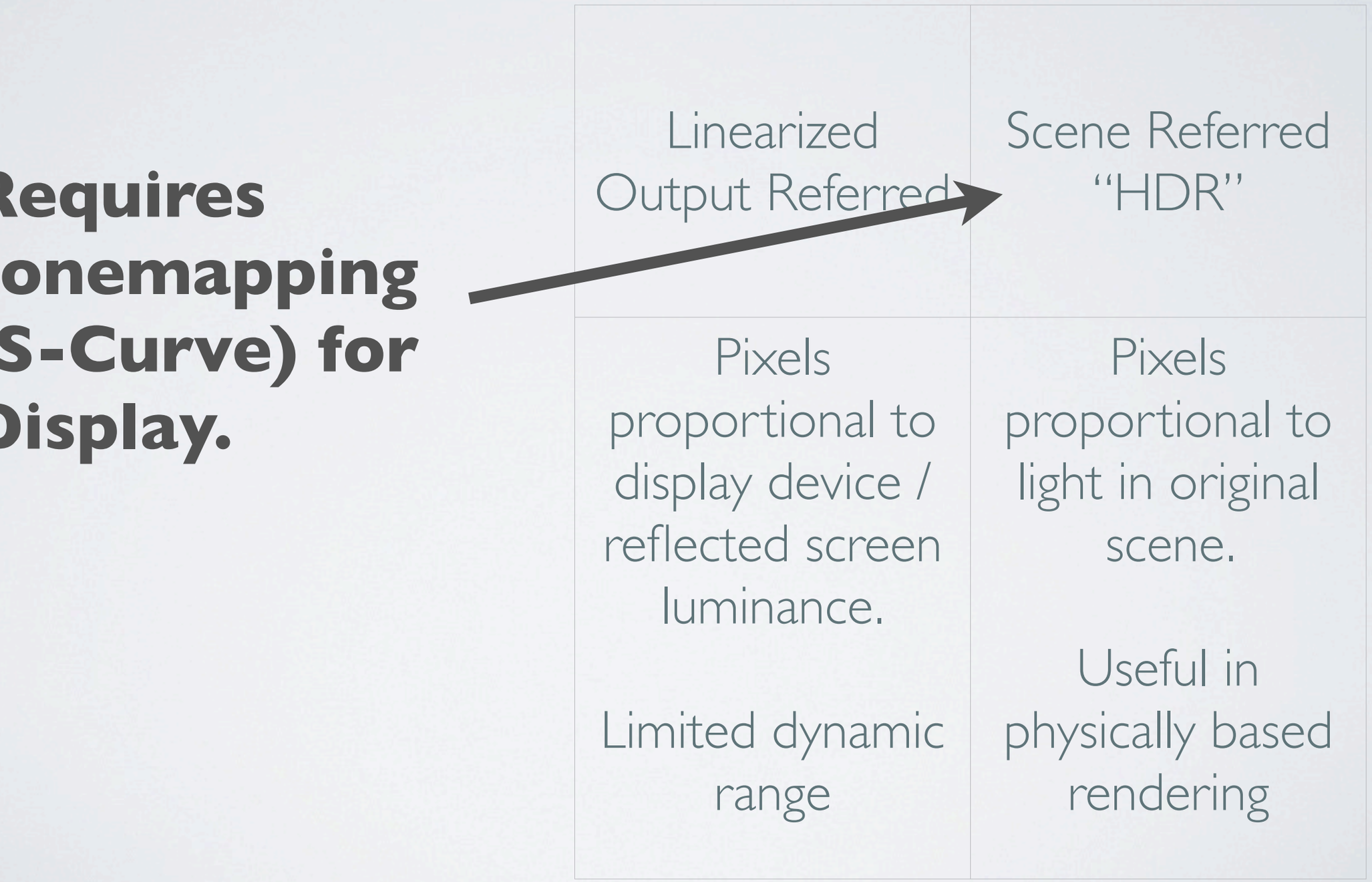
HDR Scene-referred (0.18 middle gray. max white undefined)

Linearized Output Referred	Scene Referred "HDR"
Pixels proportional to display device / reflected screen luminance. Limited dynamic range	Pixels proportional to light in original scene. Useful in physically based rendering

Rendering

Inf (HDR scene-linear, float)

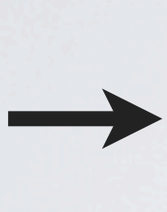
Requires tonemapping (S-Curve) for Display.




CLOUDY WITH A CHANCE OF MEATBALLS

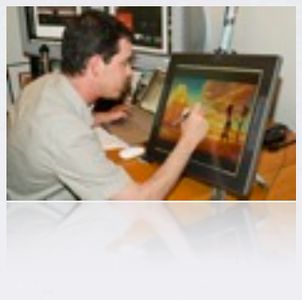
Texturing

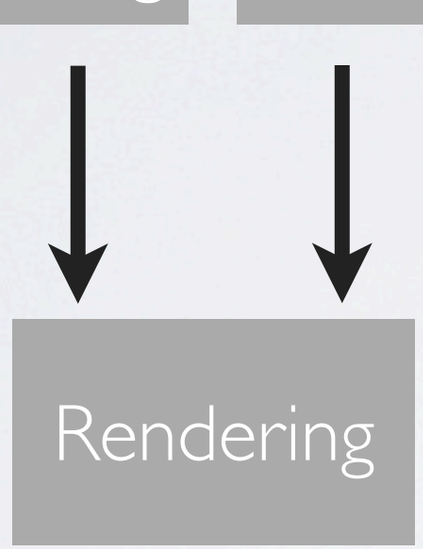
dt8 (diffuse texture, uint8)
mp8 (matte painting, uint8)



Texture Painting

Matte Painting





Rendering

- Photoshop (ocio2icc)
- Mari (native)
- Others?

Ideally WYSIWYG.

Texturing

dt8 (diffuse texture, uint8)
mp8 (matte painting, uint8)

Typically preferable to paint directly in monitor space

(I.e, inverse display transform)

(Of course, not for control maps)

Texturing

dt8 (diffuse texture, uint8)
mp8 (matte painting, uint8)

Diffuse Modulation Textures

[0-255] maps to [0.0, 1.0]

dt8

Inf

Matte Painting

mp8 (matte painting, uint8)

Matte Painting

[0-255] maps to
[0.0, >>1.0]

mp8

Inf

Texturing

dt8 (diffuse texture, uint8)
mp8 (matte painting, uint8)

When to linearize?

- In the shader (coming soon to OIIO)
- Prior to mipmapping

  OpenImageIO: **maketx** -colorconvert dt8 lnf

Compositing

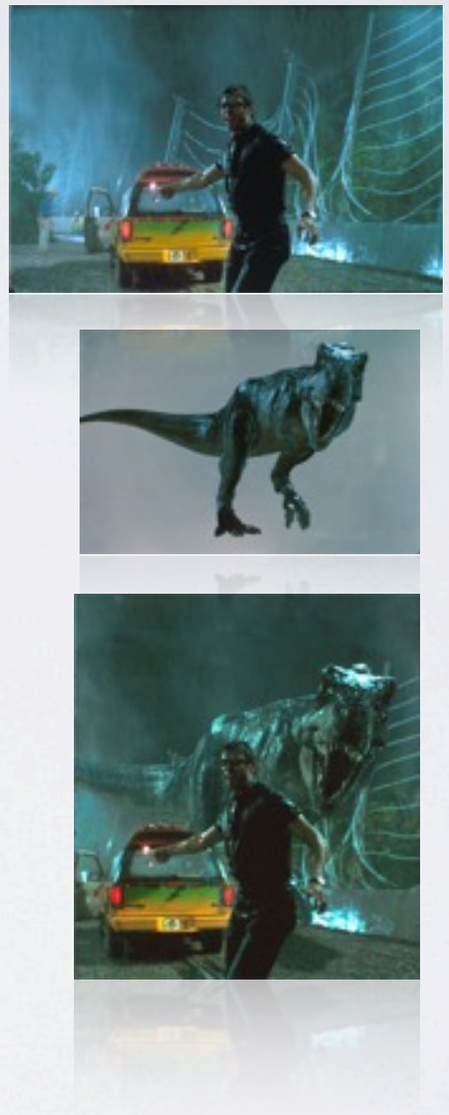
Inf (HDR scene-linear, float)

Linear renders in.

Plates in (device color space)

Delivery often in device color space (coming soon - float exr delivery using IIF's ACES)

Plate handling requires **perfect invertibility**



Compositing

Inf (HDR scene-linear, float)

Ignore built-in compositor LUT handling

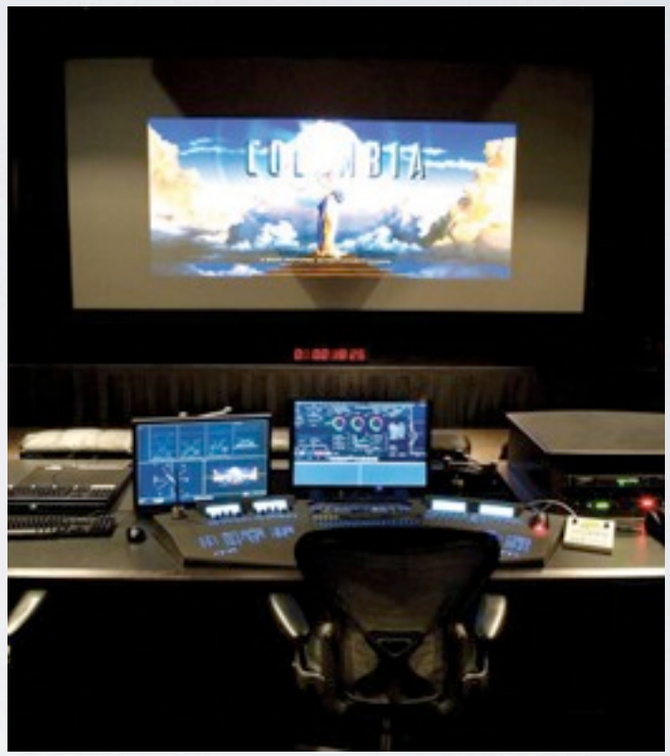
Use **OCIOColorSpace**, **OCIOLogConvert**

Ignore built-in compositor image viewing

Use **OCIODisplay**

Digital Intermediate

- Working color space for grade
- Visualization
- Output trim passes



Color Pipeline Gotchas

- Dealing with Plate Timing (working neutral)
- Not all ‘log’ spaces are equal
- HD Flavors (Full Range vs. Headroom)
- Gamma 2.2, 2.4, 2.6
- 16-bit int vs. 16-bit float roundtrip conversions

For More Info

opencolorio.org

opensource.imageworks.com

Sign up for our public mailing-list!

THANKS!

What applications do you use?

Jeremy Selan
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