HDR Working Group meeting

Telecon
8 December 2020
19:00 UTC

Attendees: Luke Wallis (Apple, HDR WG chair), Lars Borg (Adobe), Nicolas Bonnier (Apple), Craig Revie (FFEI), Chris Lilley (W3C), Chris Seeger (NBC), Phil Green (NTNU, ICC Technical Secretary)

The purpose of this meeting was to discuss a problem definition for HDR WG and a tag proposal. Relevant action items from the HDR WG meeting at the Fall 2020 ICC meetings were:

HDRWG-20-04 Propose a metadata container tag for ICC profiles to support HDR conversion, to be based on VUI (Wallis, Borg)

HDRWG-20-05 Propose an HDR problem definition for HDRWG to address (Wallis, Borg, Revie, Lilley)

1. HDR problem definition

The meeting reviewed the draft problem definition prepared by Craig Revie, with comments by Lars Borg. Revie noted that this version was more general and focused on exchanging content between ITU and ICC workflows. It was clarified that while ICC workflows aim to ensure a determinant colour appearance of images across different devices, ITU workflows are more about moving images, and optimal rendering for the target display using knowledge of the content source together with vendor-specific rendering methods. Hence ITU workflows identify the content but not the rendering to be applied. Re-mapping from HDR is common, but mapping from SDR to HDR is not excluded.

The meeting agreed that it would be useful to separate the problem statement into two parts: the first is to identify mechanisms for mapping between ITU and ICC workflows (primarily through the use of metadata such as VUI/CICP), while the second is to define how perform ITU-style processing in an ICC workflow, keeping backwards compatibility and a fall-back transform using a v4-compatible transform encoding.

2. Metadata container

Borg introduced the tag proposal, which closely followed VUI metadata from ITU-T H.273 CICP. Detailed examples are provided in the proposal but an implementer would need to reference the H.273 specification.

It was noted that a problem could potentially arise if either the ITU rendering specified in the tag was not available, or the profile was ignored. The latter case could be addressed by embedding tags in TIFF, PNG or XMP files rather than ICC profiles. The meeting agreed that the proposal was a good way to go forward, and some minor edits were suggested.

The meeting agreed the following actions:

1. Revise the proposed problem definition along the lines discussed in the meeting (Craig Revie)
2. Update the proposed votable proposal on CICP metadata for HDR as discussed (Lars Borg)

Next meeting: Phil Green will circulate Doodle poll to determine a meeting date in mid-January, also inviting Chris Seeger and Chris Needham.

Attached: updated versions of the problem definition and votable proposal.

HDR problem definition

HDRWG-20-05 Propose an HDR problem definition for HDRWG to address (Wallis, Borg, Revie, Lilley).

Problem statement

Workflows for capture, editing and display of images and graphics have been specified by ICC and ITU. The ICC model is predominantly used for still images (primarily SDR) and the ITU model is predominantly used for moving images (SDR and HDR).

Both workflows provide effective colour management while preserving as much content as possible throughout the workflow with colour conversion being applied at the last step (late binding). There are currently no recommendations for the interchange of content between these two workflows. The main goal as stressed by many is to preserve the creative intent.

This problem has three distinct aspects:

1. the reliable identification of the colour encoding used by the content (enabling content interchange between the two workflows with minimal or no round-tripping loss),
2. the effective processing of ICC-based content in an ITU workflow and
3. the effective processing of ITU-specified content by an ICC workflow.

Assumptions

There are digital cameras that are able to capture high dynamic range (HDR) images and video.

There are displays that are designed to display HDR images and video.

HDR (and SDR) video is colour managed today in cameras, NLEs, phones, and TVs, entirely without ICC profiles, including on many devices where ICC profiles are available.

There is widespread adoption of ICC colour management in computer systems, mobile phones, web browsers and support for ICC Profiles in still image and document formats[1].

There are two basic HDR philosophies loosely described as Hybrid Log Gamma (HLG) and Perceptual Quantisation (PQ) and handling of content encoded using these for broadcast television is well defined in a series of ITU recommendations.

The ITU has developed a set of recommendations for conversion between HLG and PQ and between each of these and the traditional Rec. 709 model. These models (or variations of them) are widely used for the display of video.

The majority (perhaps all) video exchange is based on these ITU recommendations. In some cases, additional metadata is included to provide rendering hints. There are many flavours of HDR rendering metadata; some are for the entire clip (HDR10), some are by frame (Dolby Vision)[2].

Important sources of HDR still images are from HDR video and direct capture from an HDR camera.

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[1] This support is currently limited to support of standard dynamic range (SDR) imaging. The ICC Specification does support a limited form of HDR imaging but that is currently not widely used.

[2] The metadata is intended to be applied only in the final consumption device. Applying the metadata earlier in the editor, especially the frame-specific metadata, can cause frames to be rendered inconsistently, can make editing, color keying, and color grading practically impossible, and can seriously limit the creative intent. A relation to graphics art: Maybe this is similar to not applying OutputIntent while editing a document.

Popular HDR spaces include:

- Video & cinema: ITU-R BT.2100 PQ|HLG, ACES/ACEScg/ACEScct …
- Still images: TBD.

Proprietary HDR workflows: Dolby Vision.

See "The Flavors of HDR video" for more details of HDR video.

ICC known issues

There are some aspects of the ICC model[3] that make support for HDR imaging difficult. It assumes:

- that a source and destination transform can be defined independently of image content,
- that a source transform can be defined independently of the destination device and
- that a destination transform can be defined independently of the source.

There are some secondary issues. It assumes:

- that the display device does not change and that any given display values will produce the same colour.

ITU / ACES known issues

SMPTE HDR report in 2015: https://www.murideo.com/uploads/5/2/9/0/52903137/study_group_on_high-dynamic-range-hdr-ecosystem.pdf

Additional notes from Lars

The big Q: Are we addressing color in the consumption device? Or in the editing device?

Some things I'm missing:

On computers, ICC display profiles are present. In video players, these seem to be used for SDR displays only. So far I haven't seen any HDR display profiles.

Some HDR displays accept HDR encoded pixel data, such as BT.2100 PQ.

Both MacOS and Windows have HDR display buffer color spaces (not using ICC) that use a fixed color space and extended ranges for channel values, for example sRGB with half-float encoding, or BT.2100 PQ. You can't determine the display gamut from this color space info.

We might want to do an inventory of these HDR computer display spaces.

AFAIK HDR videos are rendered on computers without use of ICC profiles.

AFAIK Adobe After Effects is the only product that applies ICC profiles to video sources.

What are the differences between HDR video and HDR stills?

There is of course an intersection such as HDR stills used as background plates in HDR video, and HDR video processed as stills for pixel editing,

But what's outside the intersection? Are there additional aspects that are unique for stills or video? Do we know of HDR stills color spaces that will not be part of video? Etc.

At the end we can tabulate the shortcomings (versus the goals here) of various current color management systems, including ICC, ITU, ACES, ??

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3 There are extensions in iccMAX that are intended to address some of the ICC v4 limitations. While I don't think this approach should be ruled out, it may be difficult to persuade users that this is the right direction as the solution is necessarily complex.

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ICC Votable Proposal Submission

Title of proposal

Coding-independent code points (CICP) for video signal type identification

To discuss:

- *Does this give us a robust workflow?*
- *Is ICC profile the right place? Versus a TIFF or PNG tag or XMP?*
- *Provide more workflow details*
- *√ Keep YCbCr!*
- *√ Call it CICP instead of VUI!*
- *√ Mention other equivalent color space types (SMPTE ULs…)*
- *Add links to background docs describing video workflows?*

Proposers:

Names and member companies of proposers

Lars Borg, Adobe
Chris Seeger, NBCU

Submission date:

Date of submission to ICC Technical Secretary for distribution to membership

TBD

1. Introduction

Outline of proposal, its motivation and context

A summary

This proposal enables the linking of an ICC profile with an equivalent video signal type identification (CICP) representation.

The problem to be solved

There is currently no best practice for linking the color space encoding represented by an ICC profile with an equivalent video signal type identification (CICP) used in video equipment compliant with ITU-T H.273 and ITU-T H.265 as defined by the International Telecommunication Union (ITU) or as defined by SMPTE Universal Labels.

There is no best practice for reliably exchanging still images between graphics workflows and video workflows using the correct color space.

There is no best practice for integrating ICC-tagged still images into video presentations and rendering these stills the same way as the video is rendered.

In video equipment, a video frame can be processed as scene-referred or display-referred as needed and as prescribed by video standards, but ICC profiles allow only one such processing option per ICC profile.

The solution

The proposal adds an optional CICP tag, which includes the Coding-independent code points (CICP) for the profile's effective color image encoding. The proposal is applicable to Input and Display profiles using the RGB or YCbCr color models.

The application

A processor receiving media with a CICP tag can use the CICP tag to switch its color processing from using the ICC profile to using its video color processor. This enables the processor to render ICC-tagged content the same way that untagged video is rendered, thus providing seamless integration with video-based processing such as gamut and tone mapping and other features of its video color processor.

A video frame grabber can save the video frame as RGB or YCbCr with an embedded ICC profile and embedded CICP tag.

When saving as YCbCr, the frame is in the same color space as the original video and can be re-inserted into the same video type without any loss. The ICC profile provides an approximate color rendering (typically display-referred) for non-video equipment, while the CICP tag provides the mapping back to the original video space.

When saving as RGB, the frame is typically converted from the video's narrow range YCbCr format to full range RGB of the same color space, placing black at 0. This facilitates editing in image applications. The ICC profile provides an approximate color rendering (typically display-referred) for the graphics application, while the CICP tag enables converting back to the original video space.

Issues

Identify shortcomings

What can go wrong?

- Using the CICP tag can result in a different color appearance versus using the ICC profile. What happens if this image and profile propagates into print publishing, PDF, web pages, where only some apps support the CICP tag?

2. The acceptance of this proposal will result in:

Summary of proposed changes to ICC specifications and (where required) CMM behavior

The proposal extends ICC.1 Version 4 by defining an optional Version 4 tag (cicpTag) and corresponding tag type (cicpType).

There are no required changes for CMMs.

3. Nature of the proposal

State whether tag or type(s) are being proposed, the effect on ICC resources such as registries, and consequence for ICC specification versions

The proposal extends ICC.1 Version 4 by defining an optional Version 4 tag (cicpTag) and corresponding tag type (cicpType).

This proposal does not impact ICC registries.

4. Votable Proposal

Full description of proposal

See next main section below.

5. Applications and Workflows

Usage scenarios envisaged as a result of the proposal

Workflow would include:

- Input to post-production editor, compositer, 3D software, still graphics editor
  - ICC CICP tag detected, transform applied to conform to the video space of the timeline or working space's color volume
- Input into Still Store (for static graphics playback)
  - ICC CICP tag detected, transform applied to preset still-store broadcast working space
- Input to web browser for compositing and rendering
  - ICC CICP tag detected from source graphic, broadcast video tag is detected, graphic is mapped properly into desktop working space

EXAMPLE:

Video - frame grab - PNG - editing, masking, adding text… - PNG - insert in video

File: CICP Votable Proposal 2020-12-08.docx

CICP Tag and Type proposal

√ *Change VUI to CICP! Retain YCbCr!*

1.1.1.1 Normative References

Recommendation ITU-T H.273 (12/2016), Coding-independent code points for video signal type identification, https://www.itu.int/rec/T-REC-H.273/en

1.1.1.2 Abbreviated terms

CICP Coding-independent code points for video signal type identification

1.1.1.3 cicpTag

Tag signature: ‘cicp’ (63696370h)

Permitted tag type: cicpType

This tag defines Coding-independent code points for video signal type identification (CICP).

The color image encoding specified by the CICP tag content shall be equivalent to the color image encoding represented by this ICC profile.

This tag may be present when the data colour space in the profile header is RGB or YCbCr, and the profile class in the profile header is Input or Display. The tag shall not be present for other data colour spaces or profile classes indicated in the profile header.

1.1.1.4 cicpType

The cicpType specifies Coding-independent code points for video signal type identification. The byte assignment and encoding shall be as given in Table 1~~Table 1~~.

Table 1 — cicpType encoding

Byte position	Field length (bytes)	Content	Encoded as
0 to 3	4	‘cicp’ (63696370h) type signature	
4 to 7	4	Reserved, shall be set to 0	
8	1	ColourPrimaries	uInt8Number
9	1	TransferCharacteristics	uInt8Number
10	1	MatrixCoefficients	uInt8Number
11	1	VideoFullRangeFlag	uInt8Number

The fields ColourPrimaries, TransferCharacteristics, MatrixCoefficients, and VideoFullRangeFlag shall be encoded as specified in Recommendation ITU-T H.273. Recommendation ITU-T H.273 provides detailed descriptions of the code values and their interpretation.

NOTE: Recommendation ITU-T H.273 describes the fields as follows:

The field ColourPrimaries indicates the chromaticity coordinates of the source colour primaries in terms of the CIE 1931 definition of x and y as specified by ISO 11664-1.

The field TransferCharacteristics indicates either:

- the reference opto-electronic transfer characteristic function of the source picture as a function of a source input linear optical intensity input with a nominal real-valued range of 0 to 1, or
- the inverse of the reference electro-optical transfer characteristic function as a function of an output linear optical intensity with a nominal real-valued range of 0 to 1.

The field MatrixCoefficients describes the matrix coefficients used in deriving luma and chroma signals from the red, green, and blue, or X, Y, and Z primaries.

The field VideoFullRangeFlag specifies the scaling and offset values applied in association with the MatrixCoefficients, with 0 (zero) indicating “narrow-range” encoding, 1 indicating “full-range” encoding.

EXAMPLES:

Examples for RGB images.

When the data colour space in the profile header is RGB, MatrixCoefficients is always 0 (zero) and VideoFullRangeFlag is often 1.

Codes	Interpretation
1-1-0-0	RGB narrow range representation specified in Recommendation ITU-R BT.709-6, Item 3.4
1-13-0-1	RGB full range color encoding specified in IEC 61966-2-1 sRGB
9-14-0-0	R’G’B’ narrow range representation specified in Recommendation ITU-R BT.2020-2, Table 5
9-16-0-0	PQ R’G’B’ narrow range representation specified in Recommendation ITU-R BT.2100-2, Table 9
9-16-0-1	PQ R’G’B’ full range representation specified in Recommendation ITU-R BT.2100-2, Table 9
9-18-0-0	HLG R’G’B’ narrow range representation specified in Recommendation ITU-R BT.2100-2
9-18-0-1	HLG R’G’B’ full range representation specified in Recommendation ITU-R BT.2100-2

Examples for narrow-range YCbCr or ICtCp images.

When the data colour space in the profile header is YCbCr, MatrixCoefficients is always non-zero, and VideoFullRangeFlag is usually 0 (zero). ICtCp images use the YCbCr data colour space in the profile header.

Codes	Interpretation
1-1-1-0	YCbCr representation specified in Recommendation ITU-R BT.709-6, Item 3.4
9-14-9-0	Y’Cb’Cr’ narrow range representation specified in Recommendation ITU-R BT.2020-2, Table 5
9-16-9-0	PQ Y’Cb’Cr’ narrow range representation specified in Recommendation ITU-R BT.2100-2, Table 9
9-16-14-0	PQ ICtCp narrow range representation specified in Recommendation ITU-R BT.2100-2, Table 9
9-18-9-0	HLG Y’Cb’Cr’ narrow range representation specified in Recommendation ITU-R BT.2100-2
9-18-14-0	HLG ICtCp narrow range representation specified in Recommendation ITU-R BT.2100-2

Bibliography

IEC 61966-2-1 + Amd.1, Multimedia systems and equipment – Colour measurement and management – Part 2-1: Colour management – Default RGB colour space – sRGB

Recommendation ITU-R BT.709-6, Parameter values for the HDTV standards for production and international programme exchange

Recommendation ITU-R BT.2020-2, Parameter values for ultra-high definition television systems for production and international programme exchange

Recommendation ITU-R BT.2100-2, Image parameter values for high dynamic range television for use in production and international programme exchange

Supplement 19 to ITU-T H-series Recommendations (10/2019) - Usage of video signal type code points