

HDR on the Web

(and other software platforms)

ICC HDR Experts Day, 2026-09-21
Christopher Cameron, Google Chrome

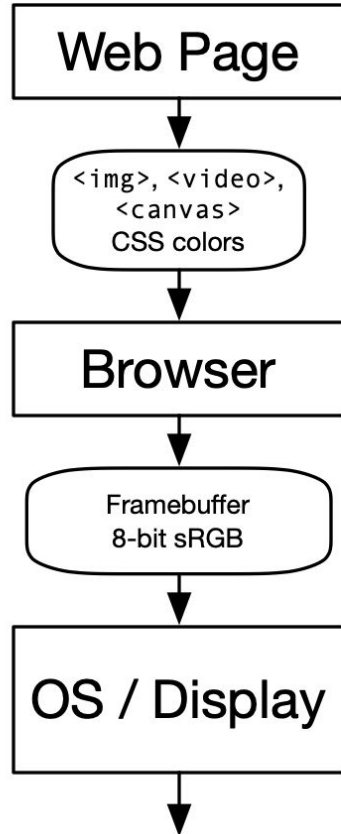
Outline

- The evolving fantasy of the web
 - The evolution from all-sRGB to HDR headroom
 - The messy reality
- HDR on the web
 - Displaying content – image, video, and colors
 - Creating content – canvas and codecs
- Things that keep me up at night

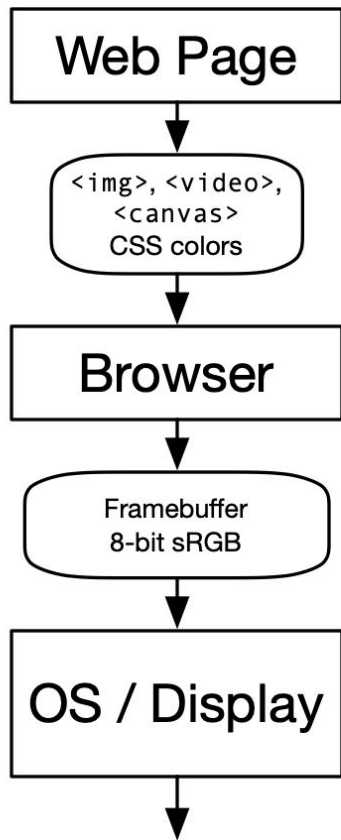
The web's view of color

The reality, and the evolving fantasy

The sRGB fantasy of a web browser (1996 to ~2007)



The sRGB fantasy of a web browser (1996 to ~2007)



CSS colors (#FF00FF) are sRGB

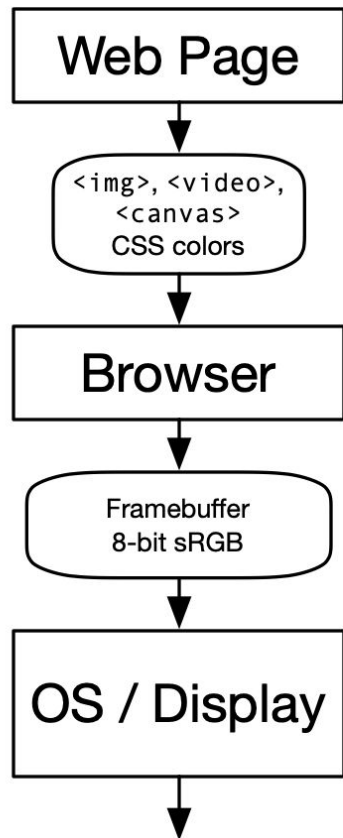
— *Images are sRGB*

Videos are sRGB (hmm)

— *Output is sRGB (no conversion ever!)*

Color is just a uint32

The sRGB fantasy starts crumbling (~2007 to ~2012)



CSS colors (#FF00FF) are sRGB

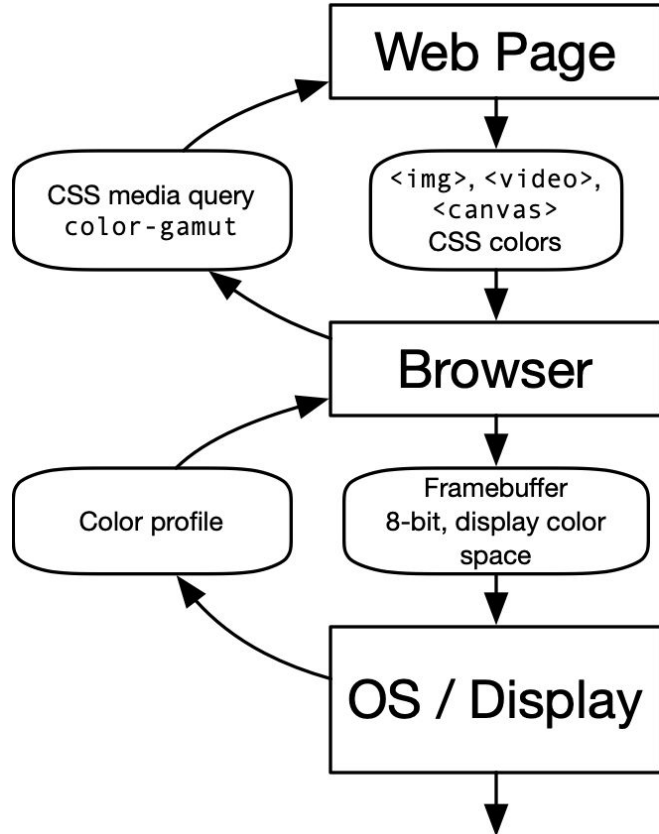
— Images ~~are sRGB~~ have color profiles

Videos are sRGB (hmm)

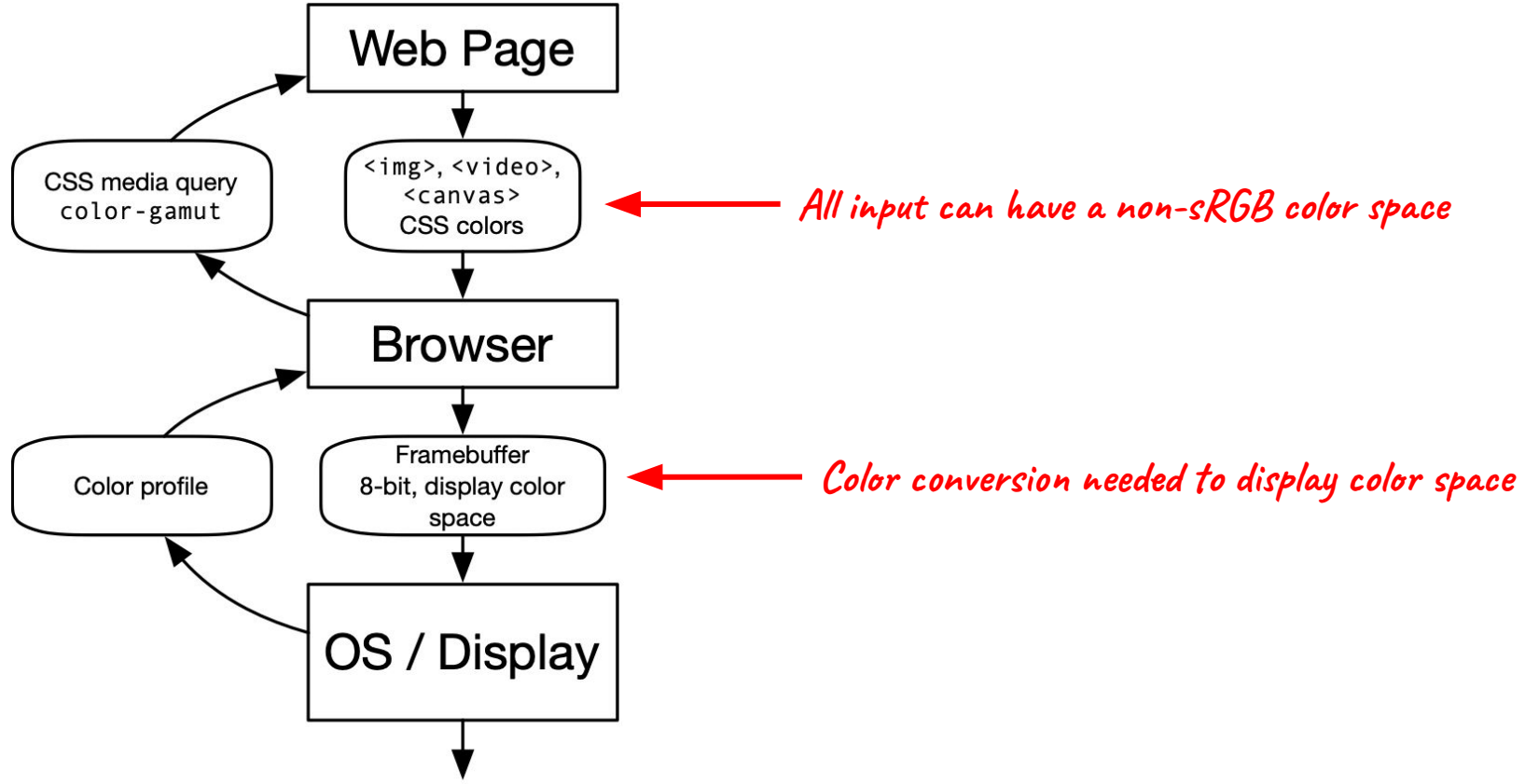
— Output is sRGB, ~~no conversion ever!~~ convert images

Color is just a uint32 (still)

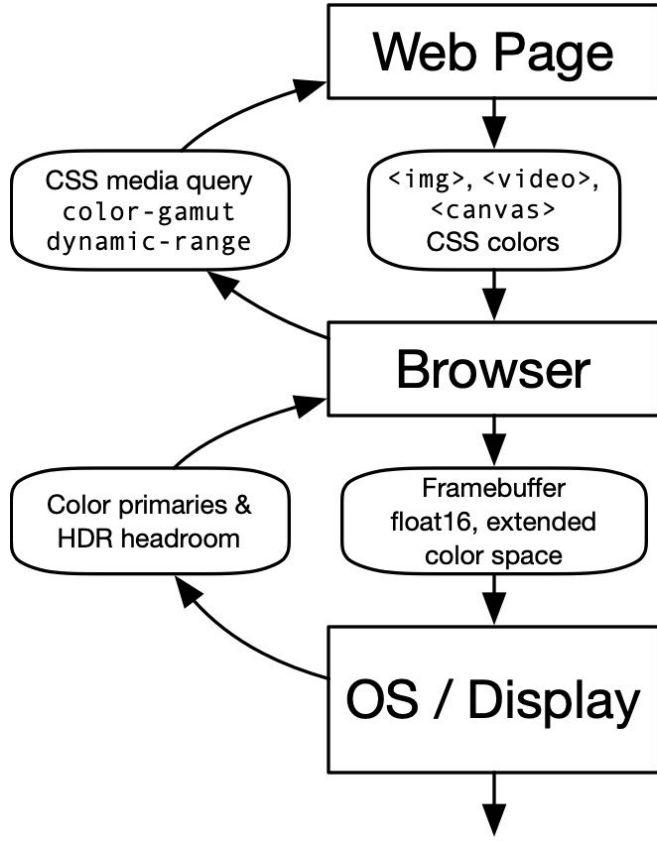
Wide gamut and hardware compositing (~2012 to ~2018)



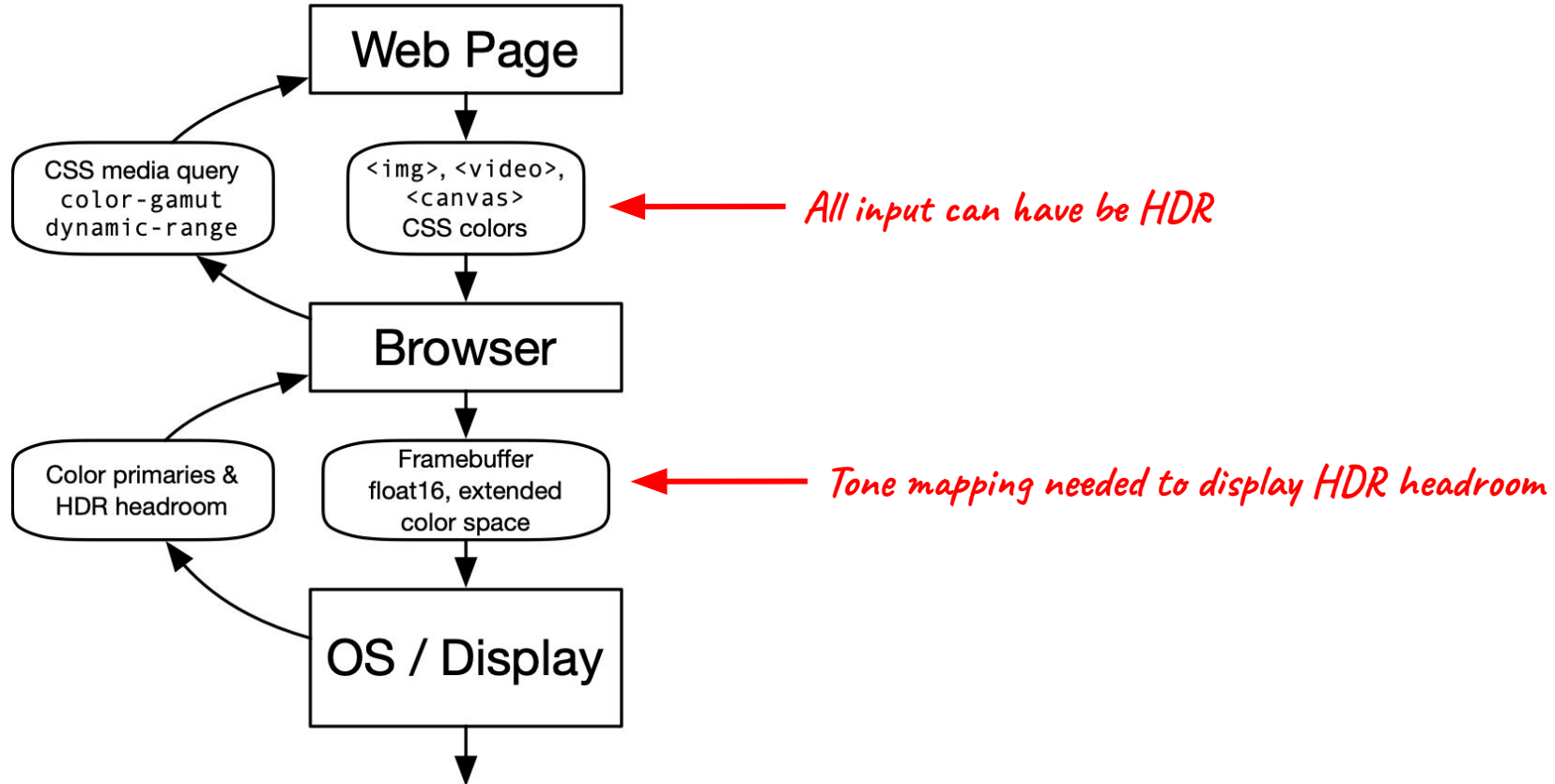
Wide gamut and hardware compositing (~2012 to ~2018)



The HDR era begins (~2018 to present)



The HDR era begins (~2018 to present)



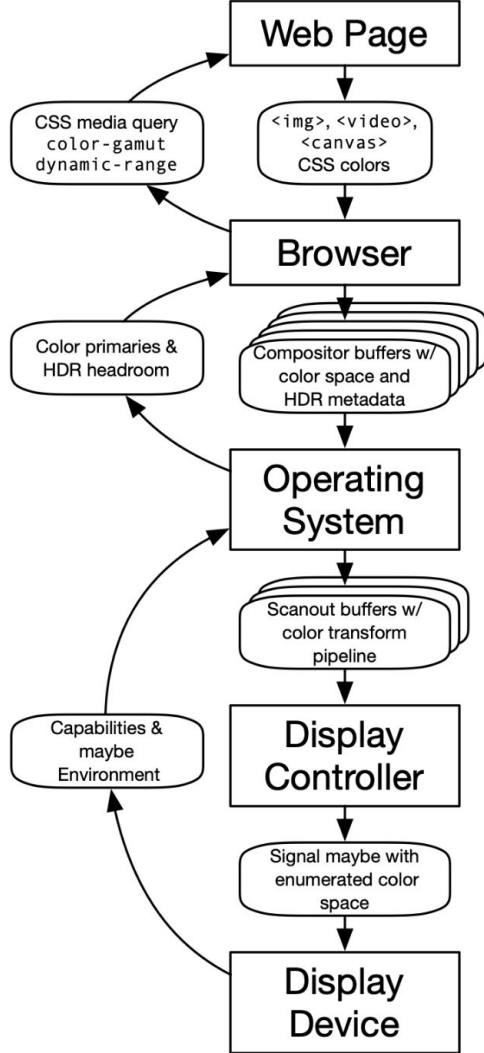
The fantasy of a web browser (modern)

Displays are characterized by their:

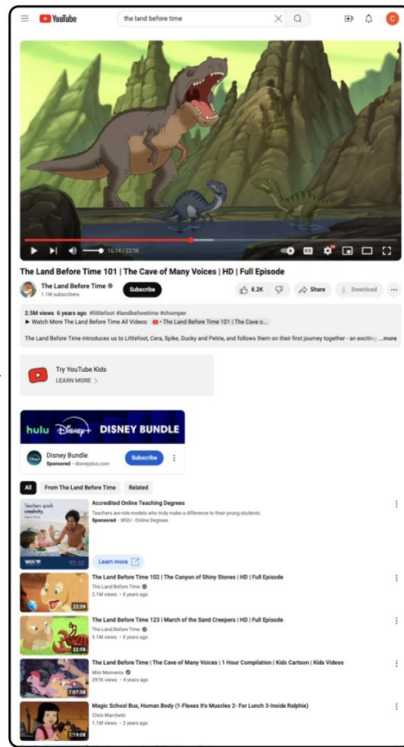
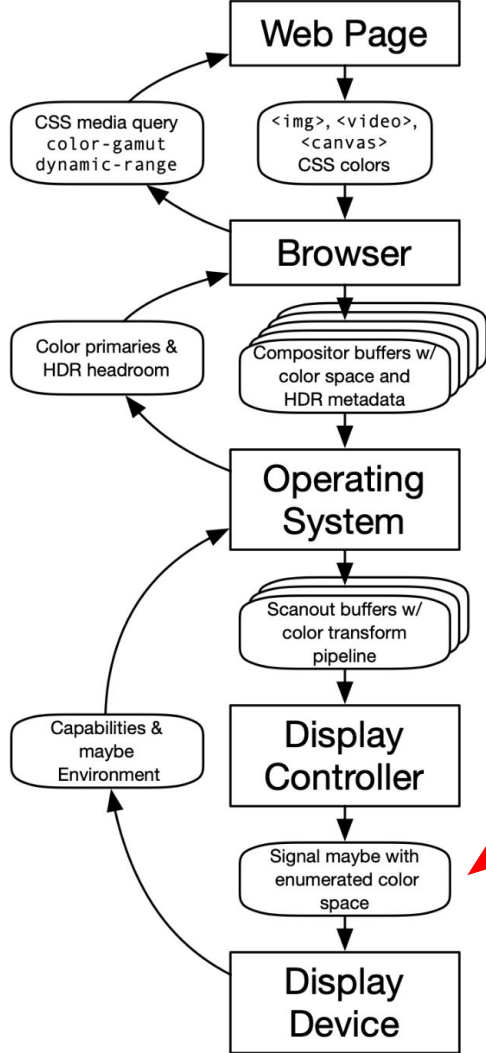
- Color primaries
- HDR headroom

Convert and tone map all input content to extended-sRGB float16 buffer.

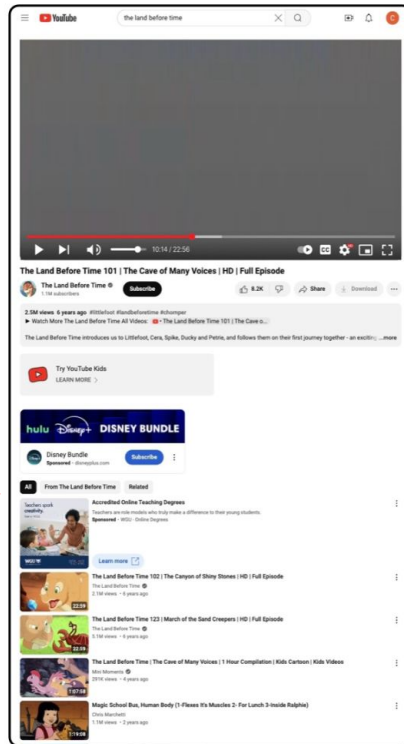
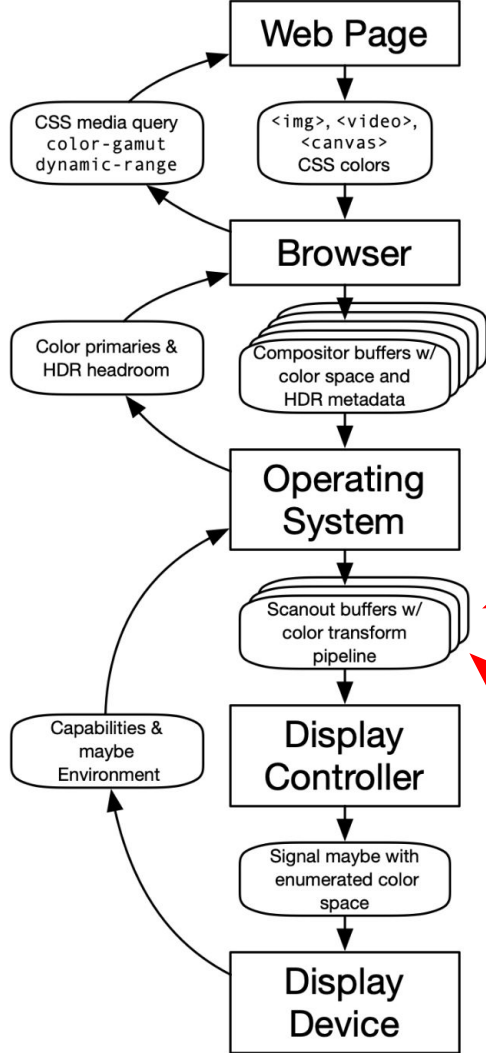
Reality
below



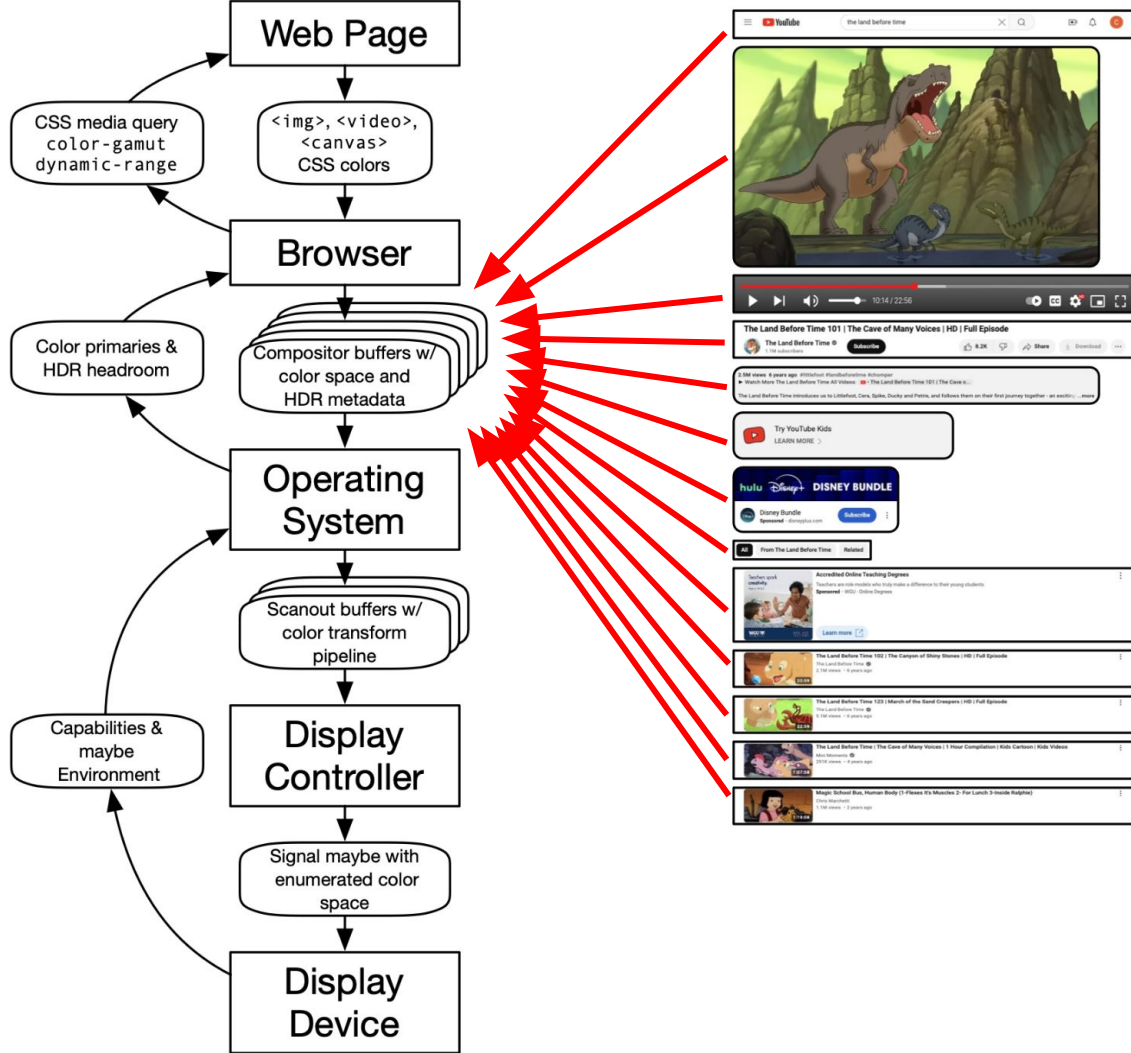
Reality
below



Reality
below



Reality
below



The fantasy of a web browser (modern)

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- HDR headroom
- Color primaries

Convert and tone map all input content to extended-sRGB float16 buffer.

In theory! (in practice:

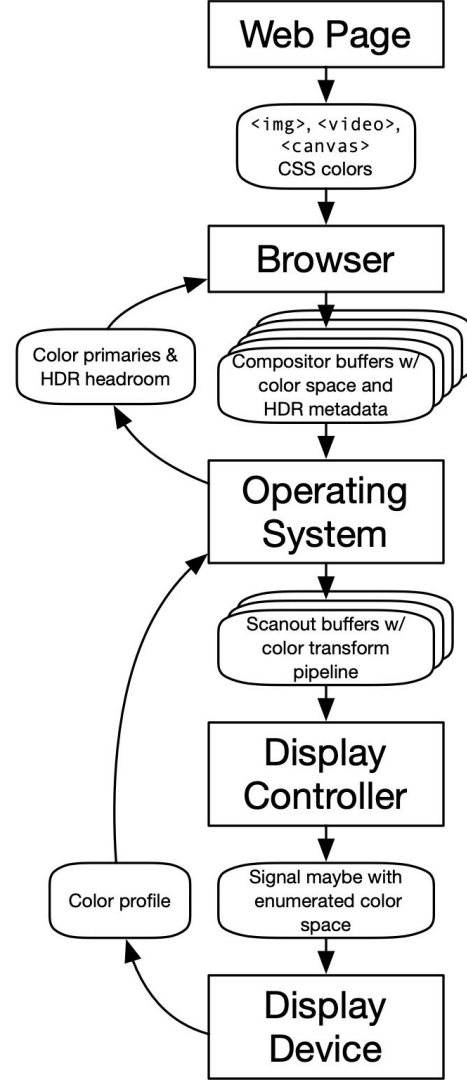
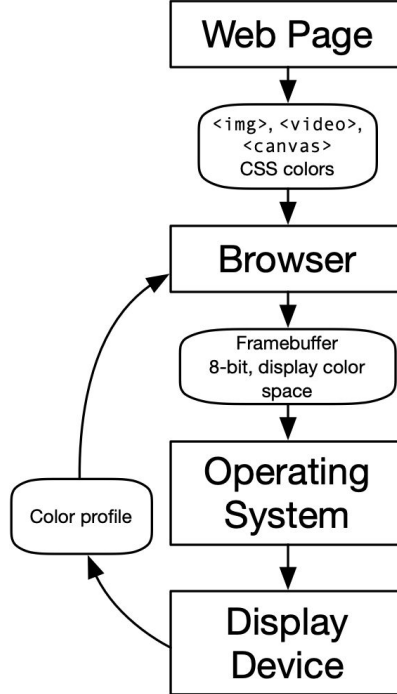
- *browser rasterizer & compositor,*
 - *OS compositor,*
 - *display controller*
- do their parts)*

Who does what?

Applications

SHOULD NOT KNOW

The display color profile

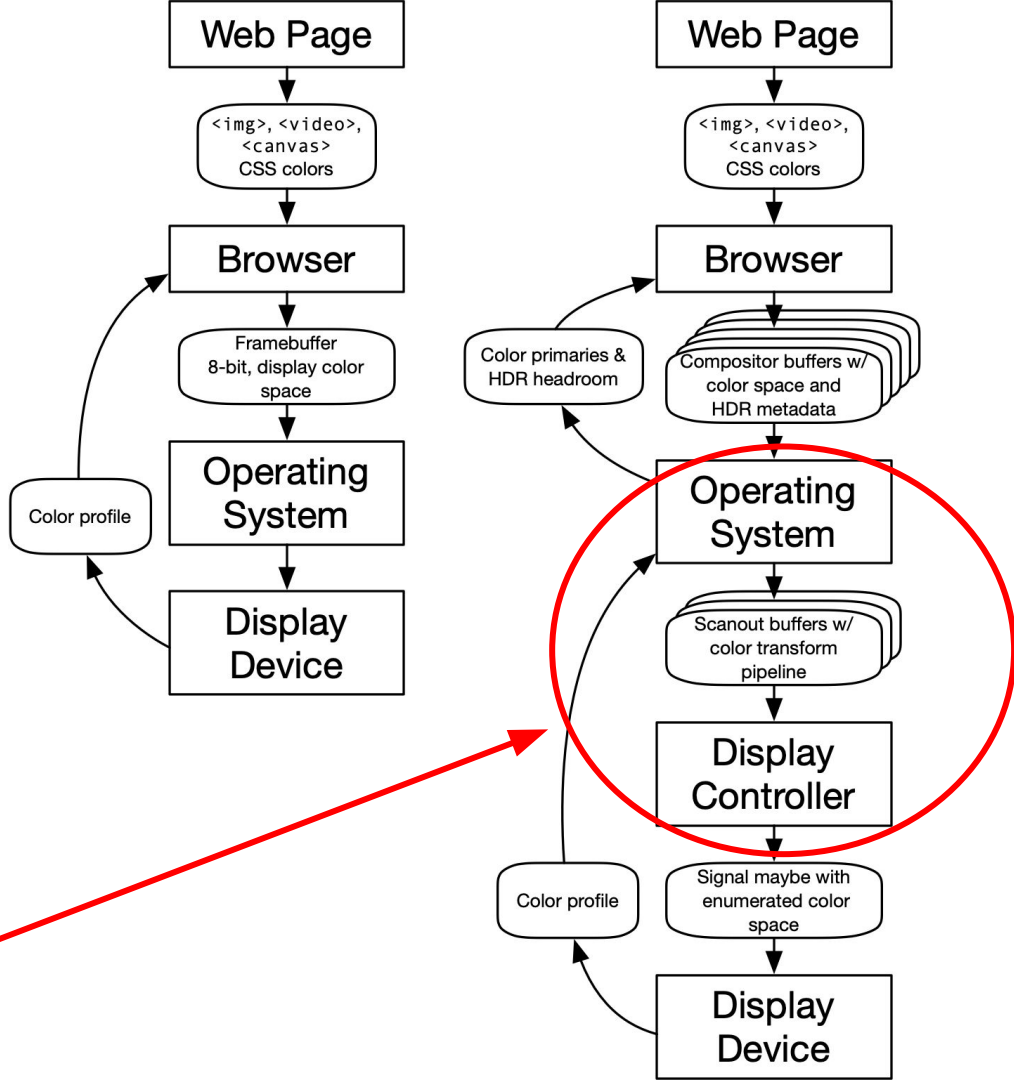


Who does what?

Applications

SHOULD NOT KNOW

The display color profile



The fantasy of a web browser (modern)

Displays are characterized by their:

- HDR headroom
- Color primaries

Convert and tone map everything to extended-sRGB float16 buffer.

Next topic!

In theory! (in practice:

- *browser rasterizer & compositor,*
 - *OS compositor,*
 - *display controller*
- do their parts)*

HDR on the web

Displaying content:
images, video, and CSS colors

HDR content on the web: Images and video

HDR <video> with HLG and PQ (via CICP) came first

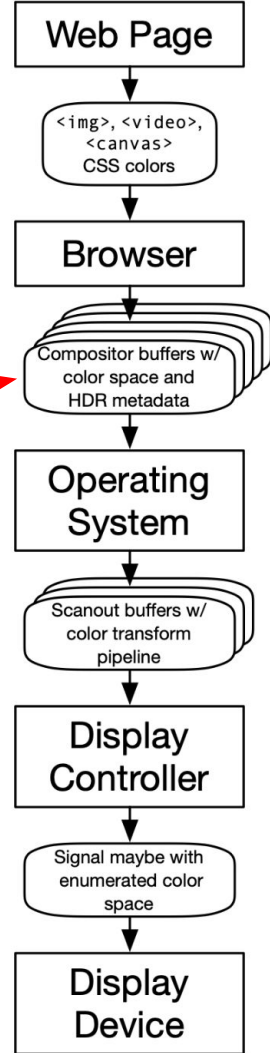
...and made a mess.

HDR content on the web: Images and video

HDR `<video>` with HLG and PQ (via CICP) came first

...and made a mess.

*Video rendering
delegated to OS (and
then to display driver!)*



HDR content on the web: Images and video

HDR <video> with HLG and PQ (via CLCP) came first

...and made a mess.

HDR <image> with ISO 22028-5 and 21496-1 gain maps came next

...and pointed to extended-sRGB with HDR headroom model!

HDR content on the web: Images and video

HDR <video> with HLG and PQ (via CLCP) came first

...and made a mess.

HDR <image> with ISO 22028-5 and 21496-1 gain maps came next

...and pointed to extended-sRGB with HDR headroom model!

HDR <image> and <video> with SMPTE ST 2094-50 is coming

...will force content into the HDR headroom model!

HDR content on the web: CSS Colors

SDR colors:

`#FF00FF`

`color(display-p3 0.5 1 0)`

HDR content on the web: CSS Colors

SDR colors:

`#FF00FF`

`color(display-p3 0.5 1 0)`

HDR colors:

`color(srgb-linear 2 2 2)`

???



HDR content on the web: CSS Colors

```
color-hdr(
```

```
    color(srgb-linear 1 1 1) 1
```

```
    color(srgb-linear 2 2 2) 2)
```

HDR content on the web: CSS Colors

color-hdr(
 color(srgb-linear 1 1 1) 1
 color(srgb-linear 2 2 2) 2)

Use this color whend display has HDR headroom 1



HDR content on the web: CSS Colors

color-hdr(

color(srgb-linear 1 1 1) 1

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Use this color when display has HDR headroom 1



And this color when it's 2



HDR content on the web: CSS Colors

color-hdr(
 color(srgb-linear 1 1 1) 1
 color(srgb-linear 2 2 2) 2)

Use this color whend display has HDR headroom 1



And this color when it's 2

*Interpolate using weighted geometric mean
(matches ISO 21496-1 and SMPTE ST 2094-50)*

HDR on the web

Creating content:
HTML canvas and codecs

HDR on the web: Creating content using 2D canvas

HTML/JS Drawing API

- Canvas context has a bitmap
- Context allows drawing (shapes, images, text, etc), to that bitmap

Color managed:

- Inputs are converted to canvas bitmap color space when drawing
- Canvas bitmap color space converted to display color space when displaying to screen

HDR on the web: Creating content using 2D canvas

```
ctx = MyHTMLCanvas.getContext("2d");  
ctx.drawImage(MyImage, 0, 0);
```

Default bitmap is 8-bit sRGB

Convert image to sRGB while drawing

HDR on the web: Creating content using 2D canvas

```
ctx = MyHTMLCanvas.getContext("2d", {  
    colorSpace:"display-p3-linear",  
    colorType:"float16"});  
ctx.drawImage(MyImage, 0, 0);
```



Convert image to Display-P3 linear while drawing

HDR on the web: Creating content using 2D canvas

```
ctx = MyHTMLCanvas.getContext("2d", {  
  colorSpace:"display-p3-linear",  
  colorType:"float16"},  
  toneMapping:{mode:"reference-white",  
               baselineLinearHDRHeadroom:4});  
ctx.globalLinearHDRHeadroom = 4;  
ctx.drawImage(MyImage, 0, 0);
```

*Tone map the canvas bitmap
using RWTMO, with baseline
HDR headroom of 4x*

*(RWTMO maps to 2094-50
metadata, see spec)*

*Convert image to Display-P3 linear and tonemap to
headroom 4 while drawing*

HDR on the web: Creating content using 2D canvas

Specify HDR headroom when drawing to bitmap

- To control tone mapping of inputs

Specify HDR tone mapping metadata for displaying bitmap

- All maps to 2094-50 metadata

Exporting (as image or streaming as video):

- Tone mapping metadata attached as 2094-50 (in ICC profile or T35)
- Linear color spaces with encoded as PQ (or HLG)

HDR on the web

What worries me

The darkest of darks

sRGB has historically been displayed as pure-gamma

Images that are pure-gamma get double-crushed

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... this can happen to PQ and HLG, too...

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... this can happen to PQ and HLG, too...

How to un-ring this bell?

“Baseline” vs “alternate” ambient brightness?

The END!

(at least for now)