Hello!
I’m Chris or @svgeesus
Technical Director at W3C
Strategy lead, Core Web Technologies
The Prehistoric Web
ITU Rec BT.709 (1990) part 2

1080i and 1080p High Definition TV
Defines chromaticities, D65 white
OETF with linear segment
Scene referred
Overall system gamma 1.2 (dim surround)
Indexed-color displays

16 color VGA displays. 256 colors common.

“Truecolor” for the lucky few
Gamma mayhem

Mac: 2.6/1.45 = 1.79
SGI: 2.4/1.7 = 1.4
PC, Unix: 2.2 (ish)
W3C Workshop on High Quality Printing from the Web, April 25th '96

bridge, Massachusetts

The workshop is sponsored by the World Wide Web Consortium (W3C).

Speakers: Dave Raggett and Susan Hardy

Papers | Topics | Agenda | Minutes | Where | Registration

Introduction

The success of the World Wide Web for online publishing, the time has now come to focus on improving the quality of printing from the Web. This one day workshop will draw together participants to identify technical issues that will enable improved quality of printing. It is intended that the workshop will lead to the formation of a W3C subgroup to address these issues with members drawn from W3C member companies and organizations.

Papers submitted by Participants

Participants are strongly encouraged to provide position papers on these or closely related topics in advance of the workshop to be made publically available on W3C's Web site.

Papers should be submitted in HTML by email to Susan Hardy at susan@w3.org. If you have trouble, you may submit a URL for the document instead.

W3C Print Workshop
sRGB proposal

Proposal to Make Web Printing More Satisfying by John C. Thomas

Since I find it easier to read long textual documents from a printed page than from my workstation screen, I find myself reaching for the "Print" button on my web browser any time a document must be scrolled more than a few times. This becomes inconvenient, however, if the document has many Hyperlinks, since the document tree must be manually traversed. The "[Next]" link which is beginning to appear on web pages from some of the more professional administered web sites is only a partial solution. The tool I want is an interactive web crawler which retrieves, indexes and prints a document and any linked documents out to some predefined sphere of context.

Publishing by Sumner M. Saitz <sumner@harlequin.com>

Harlequin as a leader in high-quality electronic printing would like to collaborate with other members of the W3C to develop open standards and solutions that meet the rapidly growing demands of the Web community.

For a Standard Color Space for the Internet by Matthew Anderson, Ricardo Motta/Hewlett-Packard, Srinivasan Chandrasekar/Microsoft, Michael Hewlett-Packard

And Microsoft propose the addition of support for a standard color space within the Microsoft OS's, HP products and the Internet. The aim of this contribution is to complement the current color management strategies by enabling a third method of handling color in the OS's and the Internet that utilizes a robust device independent color definition that will provide good quality with minimum transmission and system overhead. Based on a colorimetric space well suited to CRT monitors, television, scanners, digital cameras, and printing systems, such a space can be supported with minimum cost to software and hardware vendors. Our intent here is to promote its adoption by showing the benefits of supporting a standard color space, the suitability of the standard color space we are proposing, and describe some of the system issues and propose a methodology for its implementation on the Web.

For Font Embedding on the WWW by Andrew Pennock

A high-level proposal for embedding fonts in HTML documents on the World Wide Web. Clients interact with platform-specific services (called "embedding devices" in this document) that provide much of the embedding functionality.
sRGB

Same chromaticities, D65 white as BT.709

“Inverse OETF” with linear segment

Display referred

Overall system gamma 1.0 (normal surround)

Assumes 5% viewing flare
Cascading Style Sheets, level 1

W3C Recommendation 17 Dec 1996

http://www.w3.org/pub/WWW/TR/REC-CSS1

Authors:
Léonard de Roure (howcome@w3.org)
Albert Bos (bert@w3.org)

Status of this document

This document is a W3C Recommendation. It has been reviewed by W3C (http://www.w3.org/) Members and general consensus that the specication is appropriate for use has been reached. It is a stable document and may be used as reference material or cited as a normative source from another document. W3C promotes widespread deployment of this Recommendation.

If current W3C Recommendations and other technical documents can be found at http://www.w3.org/pub/WWW/TR/.

Abstract

Cascading Style Sheets

This document specifies level 1 of the Cascading Style Sheet mechanism (CSS1). CSS1 is a simple style sheet mechanism that allows authors and readers to attach style (e.g. fonts, colors and spacing) to HTML documents. The CSS1 language is designed to add style to the content of HTML documents without altering the content itself.
The format of an RGB value in hexadecimal notation is a '#' immediately followed by either three or six hexadecimal characters. The three-digit RGB notation (#rgb) is converted into six-digit form (#rrggbb) by replicating digits, not by adding zeros. For example, #fb0 expands to #fffb00. This makes sure that white (#ffff) can be specified with the short notation (#fff) and removes any dependencies on the pixel depth of the display.

The format of an RGB value in the functional notation is 'rgb(' followed by a comma-separated list of three numerical values (either three integer values in the range of 0-255, or three percentage values in the range of 0.0% to 100.0%) followed by ')'. Whitespace characters are allowed around the numerical values.

Values outside the numerical ranges should be clipped. The three rules below are therefore equivalent:

```css
EM { color: rgb(255,0,0) } /* integer range 0 - 255 */
EM { color: rgb(300,0,0) } /* clipped to 255 */
EM { color: rgb(110%, 0%, 0%) } /* clipped to 100% */
```

RGB colors are specified in the sRGB color space [9]. UAs may vary in the fidelity with which they represent these colors, use of sRGB provides an unambiguous and objectively measurable definition of what the color should be, which can be referred to international standards [10].

UAs may limit their efforts in displaying colors to performing a gamma-correction on them. sRGB specifies a display gamma of 2.2 under specified viewing conditions. UAs adjust the colors given in CSS such that, in combination with an output device with a "natural" display gamma, an effective display gamma of 2.2 is produced. Appendix D gives further details of this. Note that the colors specified in CSS are affected; e.g., images are expected to carry their own color information.

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A Uniform Resource Locator (URL) is identified with a functional notation:

```css
BODY { background: url(http://www.bg.com/pinkish.gif) }
```

The format of a URL value is 'url(' followed by optional white space followed by an optional single quote ('') or double quote (""), character followed by the URL itself (as defined in [11]) followed by an optional single quote ('') or double quote (""") character followed by optional white space followed by ')'. Quote characters that are not part of the URL itself must be balanced.
Color managed screens
Color Management arrives

**Mac:** ColorSync

**Win95/NT:** Kodak CMS (aftermarket)

**Win98/2000:** ICM

**WinXP:** ICM 2.0

**Linux/GNOME:** GNOME Color Manager

**Linux/KDE:** colord-kde
Not so fast
Web vs. Everything Else
Color Management in Industry

Commercial printing, production of paint, plastics, fabric, 3D print

- There is a paying customer
- Design is finished before production
- Production is centralized
- Reliable, calibrated instruments for color QA
Color Management on the Web

Even with color-managed screens:

- Content & browsers are free
- Design customized to end-user display
- Production is distributed
- End-user calibration rare
CSS Color 3 (2011)

sRGB only, 8 bits per component

Chrome, Safari color managed; Firefox threw data at screen

```javascript
fill: rgb(243, 214, 155);
// looks fine on sRGB,
// too saturated on P3 wide gamut
```
DCI P3 - SMPTE EG 432

Digital Cinema Initiative
Projectors for digital cinema
Defines chromaticities, weird white
Monochromatic red, 615nm
White luminance 48 cd/m²
Dark surround
UltraHD Premium

Conforming devices required to display at least 90% of DCI P3
VESDA DisplayHDR

(For tier 500 and greater)

Conforming devices required to display at least 90% of DCI P3
Apple Display P3

White, EOTF, viewing conditions same as sRGB
Primaries same as DCI-P3
Display-referred
Factory-calibrated phones, tablets, laptops, *watches*
*All* color managed
ITU Rec BT.2020 (2012)

Ultrawide gamut
Monochromatic primaries (630, 532, 467nm)
10 or 12 bits per component
OETF, and non-matching EOTF (gamma 2.4)
D65 white, dim surround
Display-referred
UltraHD (4k, 8k) broadcast, streaming
BT.2020 in practice

Content mostly mastered in DCI-P3
HDMI 2.0 supports BT.2020, 12bit
Content thus delivered in BT.2020 container
For HDR, metadata declares the mastering gamut volume
CSS Color 4
What changed?

- Wider color gamuts in digital SLR photography
- Apple Display P3 devices
- Dell, HP, Microsoft wide gamut laptop screens
- Samsung, Pixel, OnePlus wide gamut phones
- Wide gamut, HDR TV/movies/streaming
- Mobile CMS, *finally*
- Safari support for CSS Color 4 display-p3
Predefined Colorspaces

fill: color(display-p3 0.9341 0.8433 0.6361)
fill: color(prophoto-rgb 0.8474 0.8103 0.5824)
fill: color(rec2020 0.9151 0.8359 0.5960)
// these are the same color, L=87.16 C=38.25 H=79.93
CIE Hue, Chroma (LCH)
LCH in CSS Color 4

background: lch(50% 0 0);
border-color: lch(65% 30 180 / 50%);
color: lch(55.3% 84.5 10.25, #F06);

Hue can be NaN for neutrals
Lab in CSS Color 4

background: lab(50% 0 0);
border-color: lab(65% 46 -8 / 50%);
color: lab(55.3% 83.1 15.0 / 75%, #F06);
**CMYK:** ICC Color in CSS Color 4

At-rule (like `@font-face`) points to ICC profile

```css
@color-profile --fogra39 {
    src: url('https://example.org/C_Fogra39L.icc');
}

.header {
    background-color: color(--fogra39 0% 70% 20% 0%);
}
```
CMYKOGV: ICC Color in CSS Color 4

Not limited to 4 components

@color-profile --fogra55beta {
    src: url('https://example.org/FOGRA55beta_CL.icc');
}

.bluish_green {
    background-color: color(--fogra55beta 0.397575 0.010047 0.223682 0.031140 0.000000 0.317066 0.000000);}

Mixing & manipulating colors
CSS Color Module Level 5
Editor’s Draft, 13 November 2020

Specification Metadata
Copyright © 2020 W3C® (MIT, ERCIM, Keio, Beihang). W3C liability, trademark and permissive document license rules apply.

Abstract
This module extends CSS Color [css-color-4] to add color modification functions.

CSS is a language for describing the rendering of structured documents (such as HTML and XML) on screen, on paper, etc.

Status of this document
The final public comment of the section draft is now open for comment. A W3C Working Group Note has been published. 
Please send feedback by filing issues in Github (preferred), including the spec code “css-color” in the title, like this: “[css-color] …summary of comment…”. All issues and comments are archived. Alternately, feedback can be sent to the (archived) public mailing list www-style@w3.org.

This document is governed by the 15 September 2020 W3C Process Document.

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2 Colors
3 Mixing colors: the ‘color-mix()’ function
4 Selecting the most contrasting color: the ‘color-contrast()’ function
5 Modifying colors
   5.1 Adjusting colors: the ‘color-adjust’ function
**Mixing colors** in CSS Color 5

Two colors can be mixed in any colorspace; default is LCH

```plaintext
color-mix(teal 65%, olive);
```
Mixing colors in CSS Color 5

Individual components can be mixed

```css
--tomato: lch(52% 58.1 22.7);
--sky: lch(56% 49.1 257.1);
color-mix(var(--tomato) hue 75.23%, var(--sky));
```
Mix colors

Can be in different colorspaces
Space for mixing (LCH, Lab, XYZ)
Can specify long arc for hue mixing
Result can be out of gamut, *needs gamut mapping*
Most contrasting color in CSS Color 5

Base color, list of alternates

-\textit{myAccent}: \#b22222;

\texttt{color-contrast(wheat vs tan, sienna, var(--myAccent), \#d2691e)}

\[
WCAG\ Contrast = \frac{(Y_b + 0.05)}{(Y_a + 0.05)}
\]
<table>
<thead>
<tr>
<th>Color</th>
<th>Luminance</th>
<th>Contrast</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.749</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0.482</td>
<td>1.501</td>
</tr>
<tr>
<td></td>
<td>0.137</td>
<td>4.273</td>
</tr>
<tr>
<td></td>
<td>0.107</td>
<td>5.081</td>
</tr>
<tr>
<td></td>
<td>0.305</td>
<td>2.249</td>
</tr>
</tbody>
</table>
High Dynamic Range
Need for HDR

Consumer WCG, HDR films, series, news, sports (BT.2100 PQ, HLG)

Consumer HDR gaming consoles

Consumer WCG, HDR-ready TVs commonplace

Consumer WCG (P3) laptops, tablets, phones; HDR coming

WCG, HDR still images coming (AVIF)
ITU Rec BT.2100 (2016)

BT.2020 gamut
10 or 12 bits per component
D65 white, dim surround
PQ or HLG
Hybrid Log Gamma

Scene-referenced, relative luminance
Diffuse white at 0.75
2.5 stops highlights

Range of viewing environments (dim to bright)

“Brighter displays for brighter environments”
Perceptual Quantizer

Reference display referred, absolute luminance
Diffuse white varies (0.54, 0.58, 0.66)?
5.5 stops highlights
Dim viewing environment

“Brighter displays for more highlights”
Problems with CIE Lab

Hue *non-linearity* in blue area

Primarily designed for reflective, low-luminance (120 cd/m²), print gamuts

Hard to extend for *specular whites* brighter than paper white

Under-tested for *wide-gamut colors*, over-estimates ΔE
CSS Color HDR Module Level 1
Unofficial Proposal Draft, 23 September 2020

This version:
https://drafts.csswg.org/css-color-hdr/

Latest published version:
https://www.w3.org/TR/css-color-hdr/

Issue Tracking:
CSSWG Issues Repository

Editor:
Chris Lilley (W3C)

Suggest an Edit for this Spec:
GitHub Editor

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Abstract

This module explores additions to CSS Color 4 to enable High Dynamic Range (HDR).

CSS is a language for describing the rendering of structured documents (such as HTML and XML) on screen, on paper, etc.

Status of this document

This section describes the status of this document at the time of its publication. Other documents may supersede this document. A list of current W3C publications and the latest revision of this technical report can be found in the W3C technical reports index at https://www.w3.org/TR/.

Please send feedback by filing issues in GitHub (preferred), including the spec code "css-color-hdr" in the title, like this: [css-color-hdr... summary of comments...]. All issues and comments are archived. Alternately, you can also send your feedback to comments@w3.org.

This document was produced by a group operating under the W3C Patent Policy. W3C maintains a public list of any patent disclosures made in connection with the deliverables of the group; that page also includes instructions for disclosing a patent. An individual who has actual knowledge of a patent which the individual believes contains必要。
CSS Color HDR (unofficial draft)

Adds BT.2100 (both HLG & PQ)
Adds $J_z a_z b_z$ & $J_z C_z h_z$ (PQ-like, on LMS)
Adds $IC_T C_p$ (PQ on LMS)
Defines SDR & HDR compositing (ITU Rpt BT.2408-0)
Future challenges
CSS Compositing

Currently **gamma-encoded sRGB default**, for legacy Web/Photoshop compatibility

**Porter-Duff compositing operators**

Ideal is compositing in linear-light, such as XYZ
CSS gradients

Currently interpolate in alpha-premultiplied gamma-encoded sRGB space. Ideal is alpha-premultiplied, perceptually linear, chroma-preserving (LCH or J_2C_2h_2)
Canvas (2D rendering context)

Currently **gamma-encoded sRGB default**, 8bits/component
Now adding other colorspace from CSS Color 4
Adding 16-bit and half-float sRGB for WCG (and HDR?)
CSS Object Model

Assumes colors are 8-bit sRGB

String (serialization) based

Huge legacy JS codebase

CSS Color 4 extends with serialization of color()

CSS Typed Object Model (in development)
Expert review

W3C Colorweb Community Group

W3C joined ICC
W3C Workshop on WCG & HDR

Virtual, April 2021
Speaker submissions welcome
Thank you!

- chris@w3.org
- svgees.us
- @svgeesus