Quick Reference HDR Glossary

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technicolor

Contents

AVC

Stands for Advanced Video Coding. Known as H.264 or MPEG AVC, is a video compression format for the recording, compression, and distribution of video content.

AVC is best known as being one of the video encoding standards for Blu-ray Discs; all Blu-ray Disc players must be able to decode H.264.

It is also widely used by streaming internet sources, such as videos from Vimeo, YouTube, and the iTunes Store, web software such as the Adobe Flash Player and Microsoft Silverlight, and also various HDTV broadcasts over terrestrial (ATSC, ISDB-T, DVB-T or DVB-T2), cable (DVB-C), and satellite (DVB-S and DVB-S2).

In terms of its origin, AVC was developed jointly by the International Telecommunications Union (ITU-T) and the Moving Picture Experts Group (MPEG), which is a project of the ISO/IEC and familiar to many users because of popular and accessible MPEG file formats, like .mpg.

Bit Depth or Colour Depth

Bit Depth, also known as Colour Depth is the number of bits used for each colour component of a single pixel.

When referring to a pixel, the concept can be defined as bits per pixel (bpp) or bits per sample (bps), which specifies the total number of bits used for one pixel. When referring to a single colour component in a pixel, the concept can be defined as bits per channel (bpc) or bits per colour (bpc)

Colour Depth is only one aspect of colour representation, expressing how finely levels of colour can be expressed (a.k.a. colour precision); the other aspect is how broad a range of colours can be expressed (the gamut).

The definition of both colour precision and gamut is accomplished with a colour encoding specification, which assigns a digital code value to a location in a colour space. The colour depth for HD content is typically 8 bits (10 bits for mastering), Ultra HD and High Dynamic Range (HDR) content is typically between 10 and 12 bits for distribution and up to 16 bits for mastering.

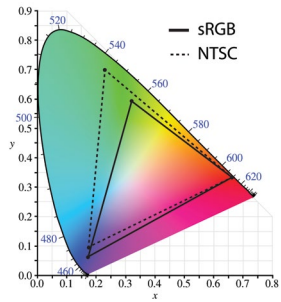
Bitrate

Describes the rate at which bits are transferred from one location to another. In other words, it measures how much data is transmitted in a given amount of time. Bitrate is commonly measured in megabits per second (Mbps) for video content, and in kilobits per second (Kbps) for music.

Bitrate can also describe the quality of an audio or video file. For example, a video file that is compressed at 3 Mbps may look better than the same file compressed at 1 Mbps, assuming the same encoding is used. This is because more bits are used to represent the video data for each second of playback. Similarly, an MP3 audio file that is compressed at 192 Kbps will have a greater dynamic range and may sound slightly more clear than the same audio file compressed at 128 Kbps.

Color Calibration of Screens

A process that ensures that colors are accurately represented on a display. Using a color meter that measures the native color response of a display, a correction metric is then computed to make sure that colors will be correctly represented on that particular display, and finally the combined response is verified.



RGB is represented in yellow and compared to NTSC.

Color Spaces

A color space is a representation of visible light and a specific organization of color.

In cinema and TV domains, we mainly use RGB (representation of a color by its Red, Green, and Blue primary components) or Yuv (representation of a color by its luminance in black and white, and its chrominance in color difference chromaticity components). These color spaces are typically based on specific display device characteristics. See also D65-P3 (p. 3).

Other color spaces such as XYZ and Lab are more representative of the human color vision model.

Contrast Ratio

It is the ratio of the luminance of the brightest (white) to that of the darkest color (black) the system is capable of producing, typically represented as a ratio of n:1.

See Sequential Contrast/Simultaneous Contrast (p. 13)

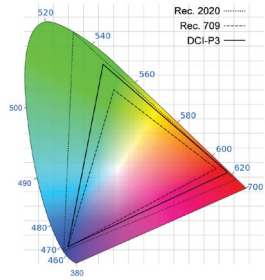
CRI (Color Remapping Information)

A set of standardized metadata generated by analyzing two masters of the same content (e.g., High Dynamic Range (HDR) and Standard Dynamic Range (SDR) masters).

When one master (e.g. HDR) is transmitted together with CRI metadata, the decoder can address HDR displays by just decoding the HDR content and can also address the SDR displays by transforming the HDR content into SDR content using the CRI metadata.

The main advantage of this approach is that for both decoded versions, the artistic intent is preserved. This is standardized as part of MPEG (HEVC v2) and included as an optional feature in Ultra HD Blu-ray.

DCI-P3, D65-P3, ST 428-1



A digital cinema color space. The DCI-P3 color space is an RGB color space that was introduced in 2005 by Digital Cinema Initiatives, LLC and standardized in 2006 by SMPTE ST 428-1.

This color space features a Color Gamut that is much wider than sRGB (see Rec. 709 p. 13).

All Digital Cinema Projectors are capable of displaying the DCI-P3 color space in its entirety. D65-P3 means that the color temperature of the white point is set at D65 instead of the “DCI” white point.

The 3 triangles show: The large color space proposed by Rec. 2020, the new standard for Ultra HD TVs, (only fully achievable on laser displays). The smaller DCI-P3 color space (Digital Cinema) and the smallest Rec. 709 space (traditional video monitors, including HD - Broadcast TV, Blu-ray, Over-The-Top).

Dynamic Range

It is the ratio between the largest and smallest non-zero values of a changeable quantity, such as in signals like sound and light. It is measured as a ratio and frequently expressed as a base-10 (decibel) or base-2 (bits or stops) logarithmic value.

EDID

Stands for Extended Display Information Data. It has been standardized by the Consumer Technology Association (CTA). This is data supplied by each Digital Video Interface (DVI) display, HDMI display, or other devices that accept DVI or HDMI as input (such devices are also called DVI or HDMI sinks). There may be as many as one EDID per DVI or HDMI input. The EDID tells connected devices the performance characteristics of the display to which they are connected.

The source device checks the display's DVI or HDMI port for the presence of an EDID memory and uses the information inside to optimize the output video (resolution, frame rate, color...) and/or audio format. All sink devices compliant to the DVI or HDMI specification must implement EDID.

EOTF

Stands for Electro-Optical Transfer Function. It is a mathematical function that maps digital code values to displayed luminance. In other words: an ETOF defines the way digital code words within image content are displayed as visible light by monitors or projectors.

See OETF, ST 2084 (p. 11)

Flicker

This phenomenon characterizes some certain types of displays like old Cathode Ray Tube (CRT) displays or badly adjusted flat panel displays, even motion picture film projectors. It is undesirable changing of brightness mainly visible at frequencies below 50 frames per seconds. In higher brightness displays, the human eye can detect flicker at higher frequencies.

Frame Rate

Also known as frame frequency, it is the number of frames or images that are projected or displayed per second. The term applies equally well to film and video cameras, computer graphics, and motion capture systems.

Frame rate is most often expressed in frames per second (FPS) or hertz (Hz). The higher the frame rate, the smoother the animation will appear, but the more processing power and system bandwidth is required.

Frame rates are typically standardized by the SMTPE, ITU, and others.

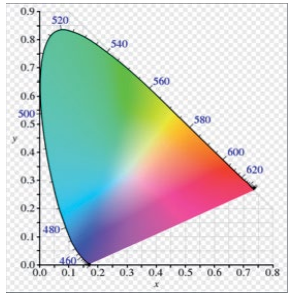
For film, television, or video, frame rate is critical in synchronizing audio with pictures.

f-stop of Dynamic Range

In photography, a change of one f-stop corresponds to a doubling (or halving) of the amount of light captured at the point of image acquisition.

The number of f-stops contained in an image describes the contrast ratio using 2N notation. For instance, if a camera is able to produce images with 10 f-stops, it means that the contrast value (ratio between white and black) can reach 210 (i.e. =1024:1) - i.e. the white will be 1024 times brighter than the black. In comparison the human eye can do 18 to 20 stops (a very High Dynamic Range (HDR) and Standard Dynamic Range (SDR) video images 6 to 7 stops.

Gamut or Color Gamut



In color reproduction, including computer graphics and photography, the gamut, or color gamut, is a certain complete subset of colors.

The most common usage refers to the subset of colors which can be accurately represented in a given circumstance, such as within a given color space or by a certain output device. Gamuts are commonly represented as areas in the CIE 1931 chromaticity diagram as shown on the left with the curved edge representing the spectral colors of the visible light range.

Gamut Mapping

In nearly every translation process (that is the transformation of the representation of a color from one color space to another), we have to deal with the fact that the color gamut of different devices vary in range which makes an accurate reproduction impossible.

These therefore need some rearrangement near the borders of the gamut. Some colors must be shifted to the inside of the gamut, as these otherwise cannot be represented on the output device and would simply be clipped. This so-called gamut mismatch occurs for example, when we translate from the RGB color space with a wider gamut into the CMYK color space with a narrower gamut range.

The color management system can utilize various methods to achieve desired results and give experienced users control of the gamut mapping behavior.

HDMI

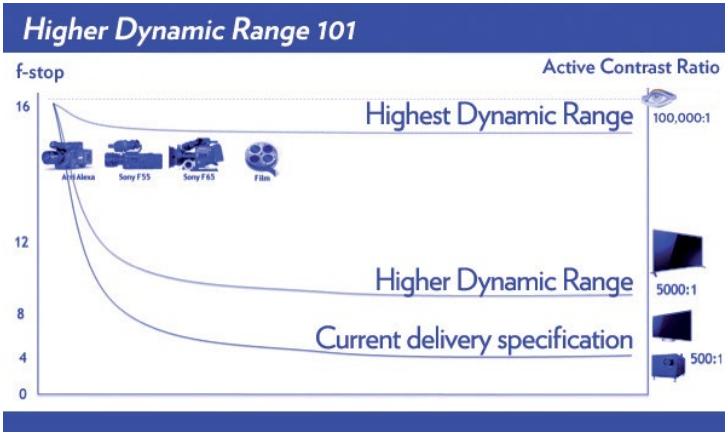
Stands for High Definition Multimedia Interface. A proprietary standard for connecting High Definition (HD) and Ultra HD equipment.

HDR

Stands for High Dynamic Range. Images containing luminance levels and/or shadow details that extend beyond the limits of traditional imaging systems. High Dynamic Range (HDR) imaging provides content creators with a wider tonal range from the darkest to the lightest areas in an image. This can be used to portray more realistic images with higher contrast, darker darks and brighter brights.

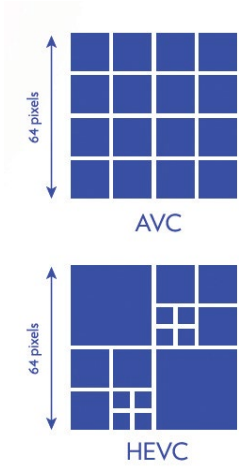
HDR System

A system specified and designed for capturing, processing, and reproducing a scene, while preserving an extended range of perceptible shadow and highlight detail, with sufficient precision and minimal artifacts, including sufficient separation of diffuse white and specular highlights.



HEVC

Stands for High Efficiency Video Coding. Also known as H.265, MPEG HEVC, and MPEG-H Part 2, and is an industry standard for video compression and a successor to H264/MPEG-4 AVC (Advanced Video Coding).



HEVC benefits over H.264/MPEG-4 AVC:

- Higher performance (same video quality with half network bandwidth): HEVC improves coding efficiency by a factor of about 2, with comparable video quality. It offers compression efficiency gains by using block structures of 8x8, 16x16, 32x32, 64x64 (AVC uses macroblocks of 16x16 only) to better match block size to the content.
- Higher resolution: up to 4k and 8k Ultra HD TV (up to 7680 × 4320)
- Future-proof: addresses the challenge of growing bandwidth demand for video and the operator's bandwidth constraints and costs (e.g., for mobile and internet streaming).

In terms of its origin, HEVC was developed jointly by the International Telecommunications Union (ITU-T) and the Moving Picture Experts Group (MPEG), in a Joint Collaborative Team on Video Coding (JCT-VC). There are several profiles (a profile is a defined set of coding tools that can be used to create a bitstream that conforms to that profile)defined in each version of a standard. The list of profiles for HEVC versions:

- Version 1 (April 2013) of the HEVC standard defines three profiles: Main (also called: HEVC 8 or HEVC 8 bits compatible), Main 10 (also called: HEVC 10 or HEVC 10 bits compatible), and Main Still Picture.
- Version 2 (early 2015) of HEVC adds 21 range extensions profiles (supporting higher bit depths and 4:0:0, 4:2:2, and 4:4:4 chroma sampling formats), two scalable extensions profiles (SHVC), and one multi-view profile (MV-HEVC).

High Frame Rate

Typically refers to 50/60 frame per second or higher. See also Frame Rate (p. 4).

Image Resolution

Image resolution is a measure of how much detail an image can contain. Higher resolution means the image can have more detail.

It can be measured in various ways. Resolution quantifies how close lines can be to each other and still be visibly resolved. Resolution units can be tied to physical sizes (e.g., lines per mm, lines per inch), to the overall size of a picture (lines per picture height, also known simply as lines, TV lines, or TVL).

The term resolution is often used for a pixel count in digital imaging. An image of H pixels height by W pixels wide can have any resolution up to H lines of picture height, or H TV lines. But when the pixel counts are referred to as resolution, the convention is to describe the pixel resolution with the set of numbers, where the first number is the number of pixel columns (width) and the second is the number of pixel rows (height), for example as 1920 by 1080.

Ultra High Definition (Ultra HD) has a resolution of 3840 x 2160 pixels, will display accurately on 16:9 aspect ratio (1.77:1) televisions (same aspect ratio as 1920 x 1080 HD image). Although 4K digital cinema projectors have a resolution of 4096 x 2160 pixels, most theatrical cinema content is projected at either 4096 x 1716 (2.39 aspect ratio) or 3996 x 2160 (1.85 aspect ratio). The terms “4K” and “Ultra HD” have become interchangeable on the market: although most “4K” TVs on the market today are Ultra HD with 3840 x 2160 pixels, many manufacturers market their TVs as 4K Ultra HD.

IMF

Interoperable Master Format (IMF) is a SMPTE standard for providing a single, interchangeable master file format and structure for the global distribution of content between businesses. An evolution of the Digital Cinema Package (DCP) architecture, providing a complete file interchange unit to the distribution channel, IMF provides a framework for creating a true file-based final master. While DCP refers to theatrical content distribution, IMF provides businesses with a master format for creating multiple tailored versions of the same piece of content for different audiences.

Inverse Tone Mapping (ITM)

Re-mastering of Standard Dynamic Range (SDR) content to High Dynamic Range (HDR). Inverse Tone Mapping takes SDR content and expands it to a broader luminance and color space, matching an HDR display’s capabilities while preserving the original content’s creative intent.

Judder/Motion Blur

Judder and motion blur are artifacts in video content related to frame rate.

A scene is acquired by a camera at a given frame rate (e.g. 24 frames per seconds) using a given shutter speed, namely the time duration when the photons hitting the sensor. A shutter speed of 50% of the frame duration would be 1/48 seconds in our example.

When motion is present in a scene, some blur appears at the edge of moving objects, this is called motion blur.

The higher the shutter speed (e.g. 1/96 seconds) the less motion blur is visible but another artifact appears: judder. It is a choppy appearance of motion caused by a frame rate being too low to express the motion well and can be uncomfortable to watch.

LCD

Stands for Liquid Crystal Display. LCD TVs have a white backlight. Tiny color filters fix sub-pixels to be either red, green, or blue. Each sub-pixel is covered by a liquid crystal valve that controls the fraction of light the sub-pixel passes. Each pixel of a display is made of at least one of each of the three colors of sub-pixel.

Liquid crystals are materials that behave as a crystal when confined to thin layers and can vary their optical properties when exposed to electric fields.

Some LCDs have a segmented backlight that allows portions of the image to be very bright by setting the segment behind to be very bright, while other parts can be very dark because the segment there is dimmed.

LUT

Stands for Look Up Table. Look Up Tables provide an efficient means of applying complex mathematical operations on input data that would otherwise be computationally expensive. As such, they are ideal for mapping an image from one color space to another.

There are:

- 3D LUTs, where each pixel's output color sample R', G' or B' is computed by a using all three of the pixels's R, G, B input color sample values.
- 1D LUTs where R' is computed using R only, G' using G only and

B' using B only. These can easily be used to apply gamma functions and other EOTF's. These are commonly implemented in chipsets for consumer electronic devices.

3D LUTs can incorporate more powerful mathematical transforms than 1D LUTs, but are more complex and expensive to implement in chipsets. They are used in post production for applying creative "looks" and color space conversions.

MaxCLL Metadata

Maximum Content Light Level (MaxCLL) is an integer metadata value defining the maximum light level, in nits, of any single pixel within an encoded HDR video stream or file. MaxCLL can be measured during or after mastering, however to keep the color grade within the MaxCLL of a display's HDR range, and add a hard clip for the light levels beyond the display's maximum value, the display's maximum CLL can be used as the metadata MaxCLL value.

MaxFALL Metadata

Maximum Frame Average Light Level (MaxFALL) is an integer metadata value defining the maximum average light level, in nits, for any single frame within an encoded HDR video stream or file. MaxFALL is calculated by averaging the decoded brightness values of all pixels within each frame.

Nits (cd/m2)

According to the Système International d'Unités, the luminance (brightness as perceived by the human eye) is measured in candela per square meter (cd/m2) but "nit" is the common colloquial term.

NRT Workflow

Stands for Non-Real-Time Workflow. Workflow capturing content to recording media, including digital file, for future processing and delivery. See also RT Workflow (p. 13).

OETF

Stands for Opto-Electronic Transfer Function. It is a mathematical function that maps scene luminance (light from a scene) to digital code values that can be transmitted or compressed. This term usually is used for image acquisition devices such as digital cameras.

In post production, content is graded on a display that has a specific EOTF, historically one that approximately reverses the camera's OETF.

OLED

Stands for Organic Light-Emitting Diode. OLED TVs don't have a backlight in the traditional sense. Each individual pixel receives its own drive current and therefore can be individually controlled. OLEDs enable a TV to have a better contrast ratio as individual pixels can be switched off to obtain absolute black even while an adjacent pixel is at maximum brightness. This increases clarity whether you're standing far away or right next to it.

OOTF

Stands for Optical-to-Optical Transfer Function. It is a mathematical function that maps scene luminance as seen by a camera to displayed luminance as produced by a monitor.

Peak Code Value

Maximum digital code value that can be passed through a system component without clipping.

Peak Display Luminance

Highest luminance that a display can produce.

PQ

Stands for Perceptual Quantizer and is an EOTF (Electro-Optical Transfer Function).

MovieLabs proposed a mathematical curve for High Dynamic Range (HDR) based on the Barton curve, standardized in 2014 by the SMPTE as ST2084.

Perceptual quantization is an efficient way to encode High Dynamic Range (HDR) luminance's. Each consecutive pair of code values differ by just less than a perceivable step across the entire dynamic range, providing very efficient use of code values.

However, this EOTF does not offer backward compatibility for legacy displays, as PQ encoded signals can only be decoded by new HDR capable devices.

The PQ is designed for 10 and 12 bit content, and per the SMPTE ST 2084 standard, is not recommended for real-time broadcast.

Quantum Dot (QD) Displays

Quantum Dot (QD) Displays work by harnessing nanocrystals "the dots" that range in size from two to 10 nanometers. Each dot emits a different, pure color depending on its size.

By adding a film carrying quantum dots in front of an LCD backlight, picture color reproduction and overall brightness are significantly improved.

These little, bitty nanocrystals enhance color gamut by 20-30% by modifying the spectra of the backlight before hitting the red, green, and blue sub-pixels thereby allowing achieving a closer match to the Rec. 2020 target color gamut.

Rec. 2020 or BT.2020

ITU-R Recommendation BT. 2020, informally known by the abbreviations Rec. 2020 or BT.2020, defines various aspects of Ultra HD TV such as display resolution, frame rate, chroma subsampling, bit depth, and color space. It was posted on the International Telecommunication Union (ITU) website on August 23, 2012.

Rec. 2020 defines two resolutions: 3840 × 2160 (4K) and 7680 × 4320 (8K). These resolutions have an aspect ratio of 16:9 and use square pixels.

Rec. 2020 specifies the following frame rates: 120p, 119.88p, 100p, 60p, 59.94p, 50p, 30p, 29.97p, 25p, 24p, 23.976p. Only progressive scan frame rates are allowed. Rec. 2020 defines a bit depth of either 10-bits per sample or 12-bits per sample.

Rec.709 or BT.709 or sRGB

ITU-R Recommendation BT.709, informally known by the abbreviations Rec. 709 or BT.709, standardizes the format of High Definition television, having 16:9 (widescreen) aspect ratio. The first edition of the standard was approved in 1990. Even though slightly different, sRBG and Rec. 709 gamuts are almost identical.

RT (Real-Time) Workflow

Stands for Real-Time Workflow. The process where content is captured and immediately processed for delivery to the consumer (i.e. Live TV), that is, content not delivered from pre-recorded media. See also Non-Real-Time (NRT) Workflow (p. 10).

SEI Message

Stands for Supplemental Enhancement Information Message. The second version of HEVC (High Efficiency Video Coding) adds several SEI messages which can be standardized or proprietary (messages that only certain terminal equipment can understand). Some significant standardized SEI messages include:

- CRI (color remapping information) provides information on remapping from one color space to a different color space.
- Knee function information suggests how to convert from one dynamic range to a different dynamic range. An example would be to compress the upper range of High Dynamic Range (HDR) video that has a luminance level of 800 cd/m2 for output on a 100 cd/m2 display. A selection of knee function processes can be supported for different display scenarios.
- Mastering display color volume describes the color primaries and dynamic range of the display that was used to author the video. The same information is standardized for production environment by SMPTE ST 2086.
- Timecode indicates the time of origin for the video. The timecode likely refers to the program timeline rather than when it was recorded.

Sequential Contrast / Simultaneous Contrast

There are several ways of measuring contrast ratios.

Sequential contrast is measured as the ratio between the brightness of a full screen white picture and a full screen black picture.

Simultaneous contrast is measured as the ratio between the brightness of a white region of a given pattern and a black region of the same pattern. Usually a black and white chessboard pattern is used.

Due to physical effects, such as optical flare, two colors shown side by side will interact with each other (crosstalk). The simultaneous contrast value is generally lower than the sequential contrast, but more representative of the quality of the display.

ST 2084

This SMPTE standard specifies an EOTF for mastering High Dynamic Range (HDR) content. This EOTF is also called "PQ", and is used primarily for mastering non-broadcast content.

ST 2086

This SMPTE standard describes the metadata items to completely specify the absolute color space (the color primaries, white point, and luminance range) of the display that was used in mastering video content.

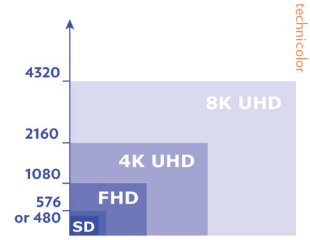
SDR/SDR System

Stands for Standard Dynamic Range. It describes a system specified and designed for capturing, processing, and reproducing a scene, with program production, processing, distribution and related display system defined and constrained by one of Recommendation ITU-R BT.601, Recommendation ITU-R BT.709, Recommendation ITU-R BT.2020, or SMPTE ST 428-1.

Tone Mapping/ Tone Mapping Operator (TMO)

Is a technique used in image processing and computer graphics to map one set of colors to another to approximate the appearance of High Dynamic Range (HDR) images in a medium that has a more limited dynamic range. Print-outs, CRT or Standard Dynamic Range (SDR) monitors, and projectors all have a limited dynamic range that is inadequate to reproduce the full range of light intensities present in HDR images. Tone mapping addresses the problem of strong contrast reduction from the recorded range to the displayable range while preserving the image details and color appearance, which are important to appreciate the original scene content and preserve creative intent. This tone mapping process is carried out using tone mapping operators, typically "S" shaped curves to roll off highlight and shadow detail. See Inverse Tone Mapping (ITM) (p. 8).

Ultra HD



Stands for Ultra High Definition (also known as Super Hi-Vision, Ultra HDTV), as defined by the Consumer Technology Association (CTA), describes any display or content with an aspect ratio of at least 16:9 (1.77:1) and a resolution at least four times higher than "Full-HD" 1080p. 4K Ultra HD (2160p) and 8K Ultra HD (4320p) are two digital video formats proposed by NHK Science & Technology Research Laboratories and standardized by the International Telecommunication Union (ITU).

"4K" televisions have a resolution of 3,840 pixels wide by 2,160 pixels high (aka 2160p), while "8K" displays have a resolution of 7,680 pixels wide by 4,320 pixels high (4320p). "4K" panels feature four times the resolution of 1080p Full-HD displays. These two formats utilize the 16:9 (1.77:1) aspect ratio, just like 720p and 1080p televisions.

Upscaling / Upconverting

Is the process to adapt content to a larger resolution than its native resolution. This process is mainly used in the options of HD television sets and DVD/Blu-ray players to display a Standard Definition TV image on a High Definition screen, or to display an HDTV image on a UHD screen.

Wide Color Gamut (WCG)

Stands for Wide Color Gamut. Its includes colors significantly more saturated than those that can be represented using Recommendation ITU-R BT.709, such as the color space defined in Rec. 2020.

White Point

A white point (often referred to as reference white or target white in technical documents) is a set of chromaticity coordinates that serve to define the color "white" in image capture, encoding, or reproduction. Depending on the application, different definitions of "white" are needed to give acceptable results. For example, photographs taken indoors may be lit by incandescent lights, which are relatively orange compared to daylight. Therefore most professional cameras have different settings for shooting under incandescent lighting vs. daylight. Likewise, images that are meant to be viewed on a display with a "D65" white point will appear incorrect on a display with a different white point.

CIE standard illuminant D65 is frequently used to define the white point for video displays.

D55 was the standard white point for film projection. Both the "DCI" white point and D60 are common for many digital cinema motion pictures.

XML

Extensible Markup Language (XML) is a computer language used to describe data that defines a set of rules for encoding documents in a format that is readable by both humans and machines. As related to Dolby Vision, XML files contain the L1 (image analysis) and L2 data (trim pass information) that accompany the HDR Master for a Dolby Vision deliverable. The XML can be delivered as a separate "side car" file or embedded in an IMF Package.

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