DRAMATIC IMAGING

DOLBY VISION FOR THE HOME

WHAT IS DOLBY VISION?

Dolby Vision™ transforms your TV experience with dramatic imaging—incredible brightness, contrast, and color that bring entertainment to life before your eyes. By fully leveraging the maximum potential of new cinema projection technology and new TVs' display capabilities, Dolby Vision delivers high dynamic range (HDR) and wide color gamut content. The result is a refined, lifelike image that will make you forget you are looking at a screen.

Current consumer video delivery and cinema standards are based on the limitations of old technologies and require altering the original content before it can be reproduced for playback—dramatically reducing the range of colors, brightness, and contrast from that captured by modern cameras. Dolby Vision changes that, giving creative teams the confidence that images will be reproduced faithfully on televisions that feature Dolby Vision.

Dolby Vision is a natural complement to Dolby Atmos®. It gives movie, television, and game creators the tools they need to create truly immersive experiences that preserve the creative intent and let consumers take advantage of modern hardware.

For manufacturers of televisions, game consoles, personal computers, and mobile devices, Dolby Vision unlocks the full capabilities of their hardware and creates a premium experience that can increase use and enjoyment of these products.

DOLBY VISION: ROOTED IN THE SCIENCE OF THE HUMAN VISUAL SYSTEM

There are three ways to improve picture quality for movies, TV shows, games, and user-generated content:

- More pixels: 4K, 8K, and beyond
- Higher frame rate (HFR)
- Better pixels (more dynamic range and wider color gamut): Dolby Vision

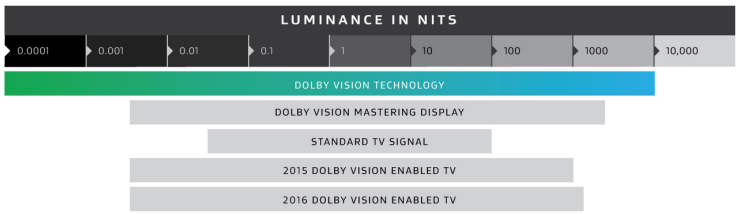
4K televisions have "more pixels," and newer standards for UHD TV also include high frame rates, but these standards don't make each pixel able to better represent the full range of brightness we see in reality. Dolby Vision is the Dolby Laboratories solution to meet this challenge.

The natural world has a much broader range of color and brightness than most current broadcast, Blu-ray™, and cinema systems support. For example, just in the simple flower shown here, brightness ranges from 145 nits for the background all the way to 14,700 nits for the yellow part of the petal. (Note: A *nit* is a unit used to measure brightness and is equivalent to a candela per square meter.)

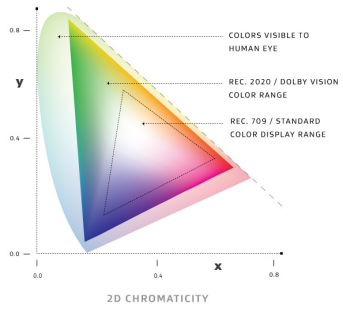
The current TV and Blu-ray standards limit maximum brightness to 100 nits and minimum brightness to 0.117 nits, while also limiting the range of colors (known as the *gamut*) that can be displayed. These and other limits to our modern HDTV standards are a legacy of the cathode ray tube (CRT).

HOW MUCH DYNAMIC RANGE DO WE NEED?

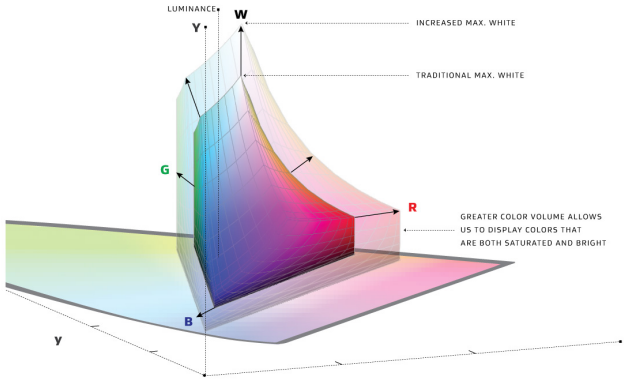
The Dolby image research team ran a set of experiments with ordinary viewers to answer this question. The researchers tested what viewers preferred for black level, diffuse white level, and highlight level. They determined that a system that could reproduce a range of 0 to 10,000 nits satisfied 90 percent of viewers asked to pick an ideal range.



One of the other critical problems with the current brightness and color range restrictions comes from how an actual TV represents color. The diagram at left below is an illustration that shows the colors the typical eye can see, along with the colors that the current HD standards can represent and the additional colors made visible by Dolby Vision. But this doesn't represent everything—to really see, you must also look at the range of brightness, the *color volume.* The graph on the right showcases the color volume and the increase in color volume that is possible with Dolby Vision.



2D CHROMATICITY



3D COLOR VOLUME

A TV display is an additive color system—red, green, blue—meaning that the brightest pixel is white. The problem with restricting maximum brightness to 100 nits (as in TV and Blu-ray) is that the brighter the color, the closer it becomes to white, so the color quickly becomes less saturated. For instance, the brightest blue on a restricted-brightness display is a mere 7 nits, so a blue sky will never be as bright as it should be. With the maximum Dolby Vision brightness of 4,000 nits using today's monitor capabilities and up to 10,000 nits in the future, a content creator has the range to represent a sky that is truly bright and saturated, making it seem more natural.

WHY DOLBY VISION?

Movie and television directors tell stories; game designers create immersive, engaging game experiences. One of the real challenges for both lies in the limitations of the medium. Dolby has worked closely with Hollywood, cinemas, and consumer equipment makers over the last 50 years to make the stories and experiences as engaging as possible—first with noise reduction, then 5.1 surround, 7.1 surround, and now with Dolby Vision and Dolby Atmos.

Dolby Vision gives the director and colorist (or the game programmer and the lighting and effects designer) the tools they need to accurately represent the vibrant colors, bright highlights, and detailed shadows that help draw the viewer into the scene.

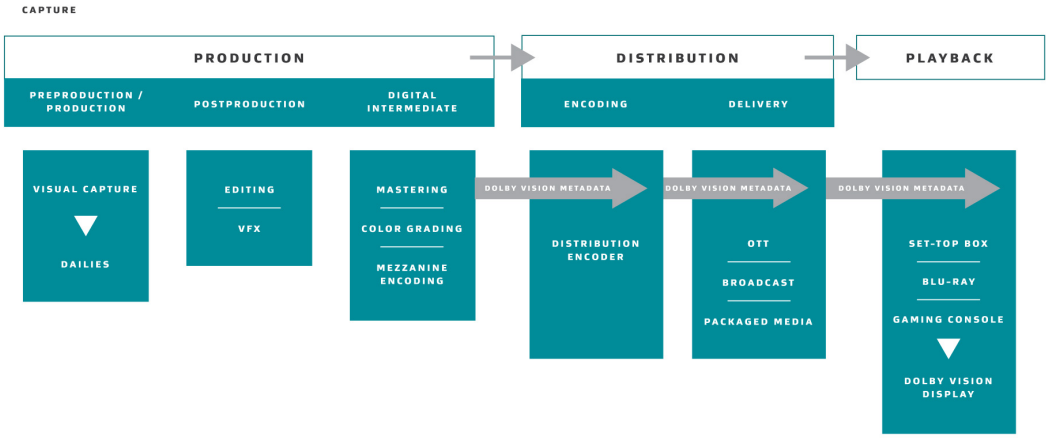
WHAT THE CONTENT CREATOR SEES IS WHAT THE VIEWER GETS

One of the challenges in today's system comes as a natural result of the limitations of current TV and Blu-ray standards. The maximum brightness for a movie or game is 100 nits. But modern TVs often have 300 to 500 nits maximum brightness, so TV manufacturers stretch the brightness of the output. This often distorts the images from what the director created. And because each manufacturer stretches the output differently, every viewer will experience a movie, TV show, or game in a different and unpredictable way.

Dolby Vision solves this problem. Content creators can now color-grade their content using prototype Dolby Vision reference monitors, which have dramatically higher dynamic range and wider color gamut, to ensure the highest-fidelity mastering. The Dolby Vision picture contains metadata about the system used to create the final version of the content. Because any Dolby Vision television has been carefully calibrated by the manufacturer and Dolby technicians, our technology can produce the best and most accurate possible representation of what the creator intended.

HOW DO YOU ENABLE DOLBY VISION?

Dolby has designed Dolby Vision to make integration into existing content creation and distribution as easy as possible.



CONTENT CREATION

The Dolby Vision workflow is very similar to existing color-grading workflows. The goal is to preserve more of what the original camera captured and therefore limit creative trade-offs in the color-grading and mastering process.

The Dolby Vision high-dynamic-range (HDR) reference grade is created in the traditional fashion except that the imagery data is specified in PQ space, a perceptual space based on the human visual system. It is a logarithmic-like curve that replaces gamma in image encoding. The PQ electro-optical transfer function (EOTF) has been recently approved as SMPTE Standard 2084.

The prototype Dolby Vision HDR reference monitor (capable of up to 4,000 nits luminance) is used to make the color and brightness decisions. The basis of the Dolby Vision grading process is to establish the artistic intent in the HDR grade. The artistic team should use the grading system and the monitors to make the best, most engaging imagery they can, taking full advantage of the dynamic range of the display.

After the reference grade is finished, the Dolby Vision capable color-grading system will analyze and save the metadata that describes the creative decisions made on the display. The content mapping unit (CMU) maps the content with the metadata to a reference display at a standard brightness (100 nits).

The algorithms developed to enable the CMU to generate the 100-nit grade will also be used in the future to enable live Dolby Vision sport productions and, in parallel, automatically generate the 100 nit version required for compatibility with today's television receivers.

After the trim pass has been approved, the colorist exports the images with metadata. The metadata generated to create the 100-nit grade can be used to render the HDR master on displays, which may offer a wide performance range. A 600-nit TV will look great, a 1200-nit TV will look even better—all referencing the same metadata and HDR reference images.

The same algorithms used in the CMU for off-line grading can be used to create a traditional compatible grade for live sports broadcast in Dolby Vision.

GAME CREATION

Most modern game engines currently support full HDR rendering. Adding support for Dolby Vision requires:

- Art created with Dolby Vision in mind
- Reference monitors to view Dolby Vision content
- Game engines compatible with Dolby Vision

Dolby is working with leading creators of game engines to ensure that their engines are compatible with Dolby Vision.

TRANSMISSION/TRANSPORT

Dolby Vision doesn't require new codecs—it is designed to take full advantage of existing HEVC and AVC codecs. The full Dolby Vision signal can be transmitted or transferred as a compatible base layer, plus a metadata stream and an enhancement layer. The client uses these data to reconstruct and play back the full signal, using existing video decoders.

Dolby is working with leading standards organizations, including the Blu-ray Disc™ Association, UltraViolet™/DECE, and the SCSA to ensure that Dolby Vision content can be delivered in a standard way.

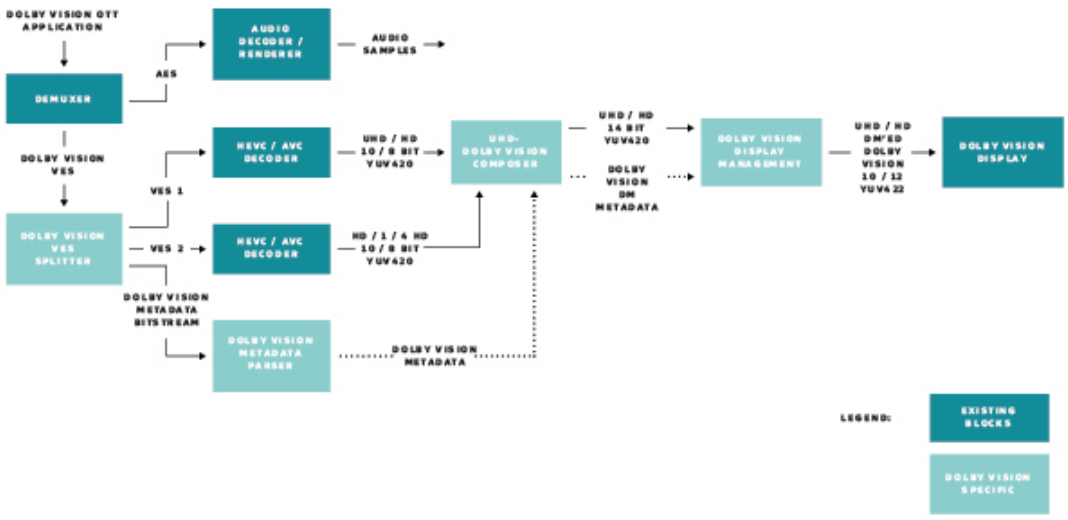
PLAYBACK

The following table shows the technology components that each type of device must support in order to play back and render a Dolby Vision signal.

TECHNOLOGY COMPONENTS	TELEVISION	SET-TOP BOX, GAME CONSOLE, DMA, PC	MOBILE OR LAPTOP
DOLBY VISION COMPOSER	YES (FOR OTT APPS)	YES	YES
DOLBY VISION DISPLAY MANAGEMENT	YES	NO	YES

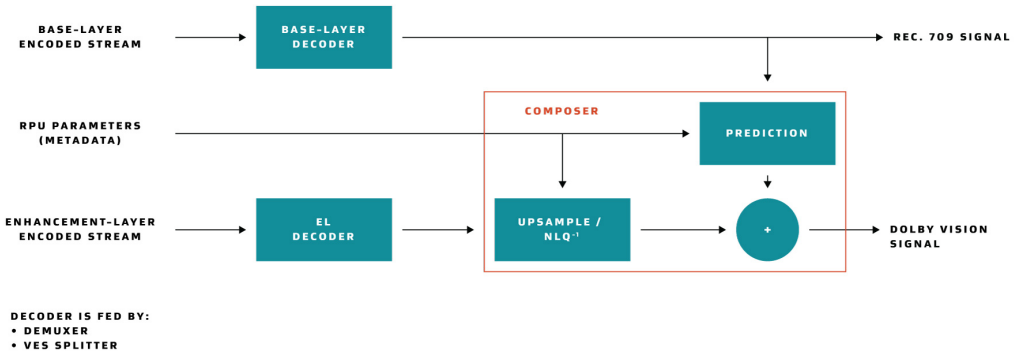
Dolby is working with its partners in the industry to provide easy-to-integrate solutions for both silicon and software-only applications

DECODER AND COMPOSER



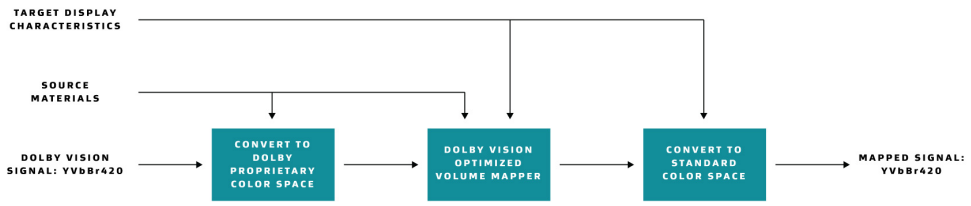
Dolby Vision is compatible with a wide range of video codecs. It's currently qualified with HEVC and AVC decoders. An implementation will take the source stream (typically a video elementary stream with interleaved base-layer AUs, enhancement-layer AUs, and metadata RPUs), split it, and feed the encoded streams through decoders.

The Dolby Vision composer is responsible for reassembling the full-range signal from the base layer, the enhancement layer, and the metadata.



DISPLAY MAPPER

The display mapper is tuned for the target display device: it knows the maximum and minimum brightness, color gamut, and other characteristics. Metadata that accompanies the full-range Dolby Vision video signal carries information about the original system used to grade the content and any special information about the signal. Using this metadata, the Display Mapper intelligently transforms the full-range signal to produce the best possible output on the target device.



SUMMARY

Technology has moved far beyond current TV and movie imaging standards. Dolby Vision takes full advantage of what's possible. This end-to-end solution delivers dramatic imaging that fully expresses the original creative intent. Dolby Vision enhances today's viewing experiences and is ready for the next wave of innovation from TV, movies, games, and streaming services.