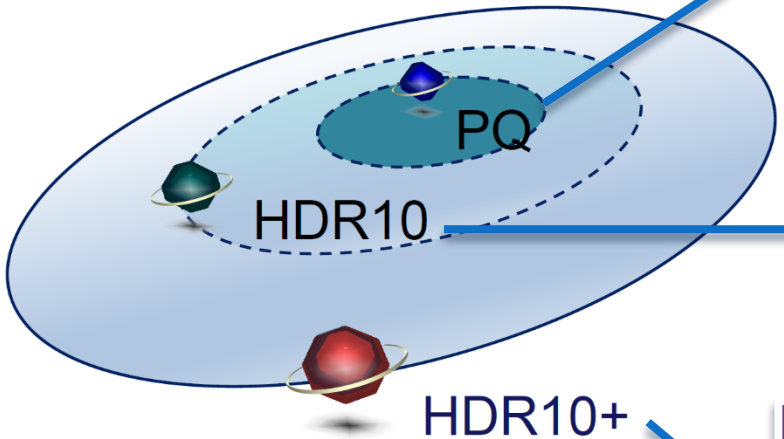
HDR10+ Technology & Content Tools

SAMSUNG – July 2018

HDR Supported by HDR10+

- HDR systems deployed since 2015.
- Studio masters delivered in “PQ” encoding. “Perceptual Quantizer”. PQ Enables content creators to exactly specify the image color and brightness as viewed on a reference monitor in the grading suite. – it’s up to displays to play this directly or adapt to the consumer’s viewing environment.
- Premium Certification of HDR content, distribution and reproduction was announced by the Ultra-HD Alliance in December 2015.
- HDR10+ metadata delivers scene specific image information enabling TVs to better handle HDR10 material on a wide range of displays and viewing conditions.

What are HDR10+ and ST 2094-40?



PQ
Perceptual Quantization
SMPTE ST 2084
"HDR Essence" Same for all HDR

HDR10 (for distribution)
10-bits
(wide color) BT.2020
(HDR) Static Metadata
SMPTE ST 2086
MaxFALL & MaxCLL

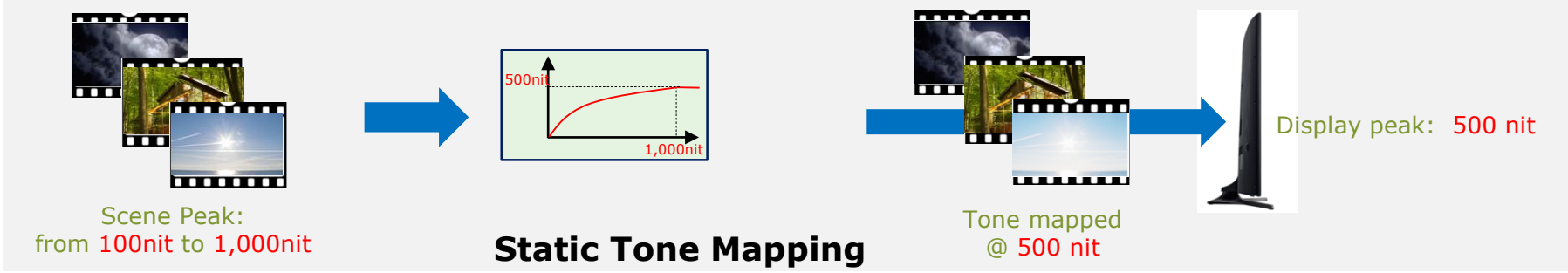
Open HDR format (2015)

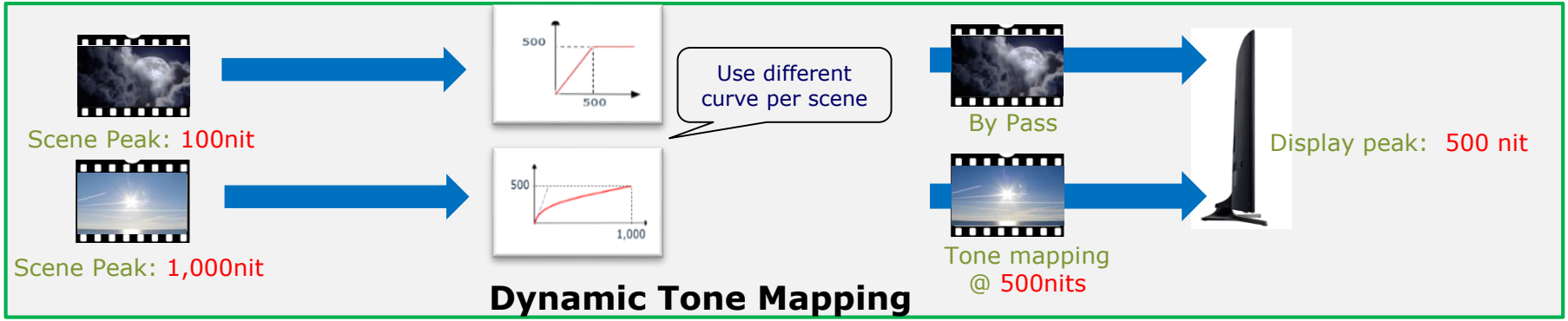
Dynamic Metadata
SMPTE ST 2094-40
Statistical Information
Basis OOTF for Guided Tone Mapping
HDR10+[LLC]
(certified 2094-40 profile; see whitepaper)
Open Technology to extend reach of HDR into mid & lower tier televisions

Dynamic Tone Mapping

- Static Tone Mapping(HDR10): Tone mapping using **static metadata(one set of metadata for entire content)** such as Mastering display information(ST 2086), MaxCLL, MaxFALL

- Dynamic Tone Mapping(e.g. HDR10+): Tone mapping using **dynamic metadata (per scene)**





6 months - December 2017 Amazon

Samsung and Amazon Prime Video First to Launch HDR10+ Content

SAMSUNG amazon HDR10+

Korea on December 13, 2017

Samsung Electronics and Amazon Prime Video today announced the entire Prime Video HDR library is now available in HDR10+, a new open standard that leverages dynamic metadata to produce enhanced contrast and colors on an expanded range of televisions. The Prime Video HDR10+ catalogue includes hundreds of hours of content such as Prime Originals *The Grand Tour*, *The Marvelous Mrs. Maisel*, *Jean-Claude Van Johnson*, *The Tick* and *The Man in the High Castle* plus hundreds of licensed titles. Prime Video is the first streaming service provider to deliver HDR10+ content to its users. HDR10+ is available on the entire Samsung 2017 UHD TV lineup – including the premium QLED TV models.

- Amazon status: HDR10+ on all HDR content.

Certification Program Opened June 20th 2018

HDR10+ Technologies, LLC, founded by 20th Century Fox, Panasonic and Samsung Make HDR10+ Technology Widely Available, Improving The Viewing Experience for Audiences

Los Angeles, CA – June 20, 2018 – HDR10+ Technologies, LLC today announced the start of the new licensing and logo certification program for HDR10+ technology. HDR10+ is the royalty-free, open standard dynamic metadata platform for High Dynamic Range (HDR), which optimizes picture quality for 4K Ultra HD displays and improves the viewing experience for all audiences.

The new HDR10+ technology optimizes picture quality for 4K Ultra HD displays by using dynamic tone mapping to reflect frame to frame or scene to scene variations in brightness, color saturation, and contrast. The resulting enhanced viewing experience can now be easily provided on a wide range of displays bringing the viewing experience much closer to the original creative intent for the content.

The HDR10+ license and logo certification is available to interested companies that meet HDR10+ technical and testing specifications. The HDR10+ certification program qualifies the compliance based on different device categories and their technical performance to ensure that HDR10+ compliant products meet high standards for picture quality.

Consumers will be able to look for the HDR10+ logo which signifies a product's certification. The royalty-free adoption of HDR10+ for content production, distribution and consumption has already gained momentum with over 40 supporting companies.

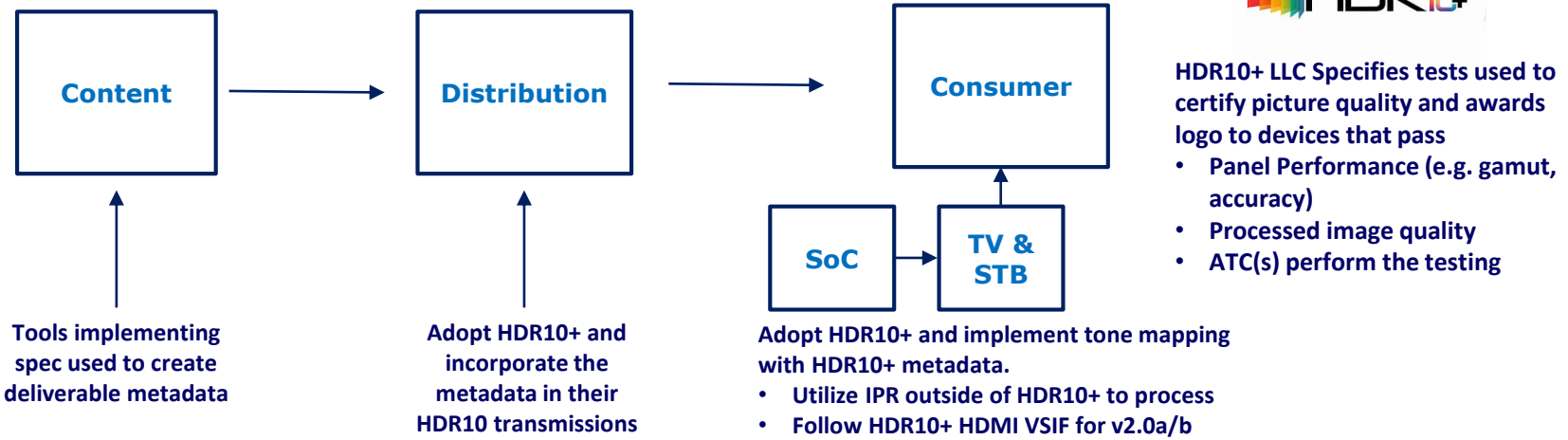
"The new HDR10+ licensing and certification program represents a technological step forward for next generation displays," said Danny Kaye, Executive Vice President of 20th Century Fox and Managing Director of the Fox Innovation Lab. "HDR10+ improves the viewing experience for all audiences by delivering higher picture quality to a wider range of affordable TVs and devices."

- ❑ Technical Spec
- ❑Test Spec
- ❑Logo Usage
- ❑Different adopter classes
  - Content
  - Source
  - Display
  - SoC
  - Tools
- ❑ Information: "HDR10PLUS.ORG"

HDR10+ LLC

HDR10+LLC is a profile, logo and certification program formed by Samsung, Panasonic and 20th Century Fox Studios.

- HDR10+ LLC Profile follows 2094-40 supporting statistics and guided tone curves. Two statistical values are interpreted as new statistical image parameters.
- HDR10+ does not specify implementations



Benefits of HDR10+ Ecosystem

- *Solves problem of gap between TV performance and content mastering characteristics*
  - *Volume zone displays 300-500 nits*
  - *Premium zone displays ~1000 nits*
- *Provides better qualified metadata than simply SMPTE 2086*
- *Wide reach of HDR content across consumer UHD displays*
- *Quality bar based on technology and certification*
- *Adoption based on open technology*

Metadata Steps

JSON → JSON → encoding → H.265 HEVC (High Efficiency Video Coding)

- **Image analysis:**
  - Identify scenes
  - Compute statistics across scene
  - Compute Bezier from statistics
  - Output JSON
- **JSON processing:**
  - Post Production workflows, clip management etc…
  - Offline encoder support
  - Represents metadata close to SEI format yet directly readable
- **'SEI' processing:**
  - Binary representation of metadata used by encoders
- **'VSIF' processing (optional)**
  - Binary representation used by HDMI
  - Derived from SEI

(Image courtesy Joe Kane Productions)

Post Production based Metadata Workflow

colorfront

1.) Generate JSON from existing source asset (e.g. ProRes)

2.) (optional) Preview default performance at target deliverable (e.g. 400 nits)

3.) (optional) Adjust any scene if desired (e.g. combine/split)

JSON

H.265 HEVC
High Efficiency Video Coding

HDR10+

Offline encoder for Blu-ray or OTT

SCENARIST
HOLLYWOOD STANDARD AUTHORING TECHNOLOGY AND PRODUCTS

New product ready for distribution

(Image courtesy Amazon Studios & ColorFront)

Straightforward Metadata Workflow & Upgrade

colorfront

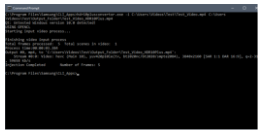
1.) Generate JSON from existing source asset (e.g. ProRes)

2.) (optional) Preview default performance at target deliverable (e.g. 400 nits)

3.) (optional) Adjust any scene if desired (e.g. combine/split)

{;}
JSON

HDR 10



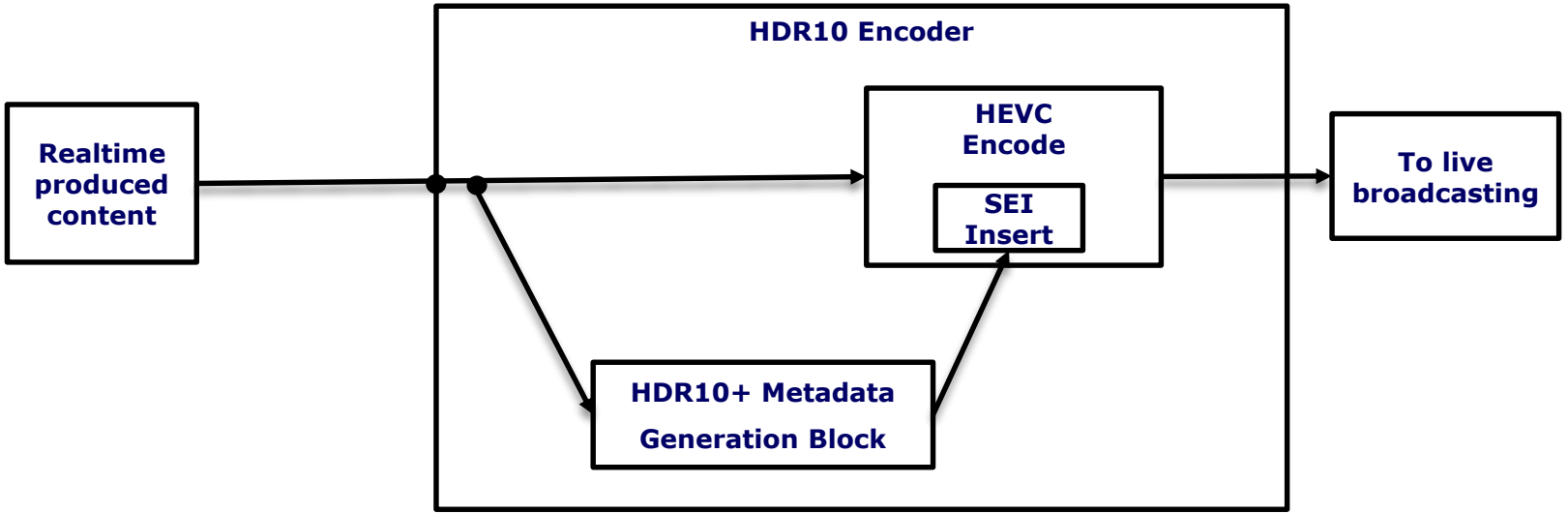
Insert metadata with command line tool

HDR10+

New HEVC track ready for distribution

(Image courtesy Amazon Studios & ColorFront)

Live Workflow



Generation algorithm included in HEVC encoder

SEI directly produced (skips JSON step)

ColorFront – NAB 2018

3C HDR10+ support: Demonstrated to studios

Main Themes:

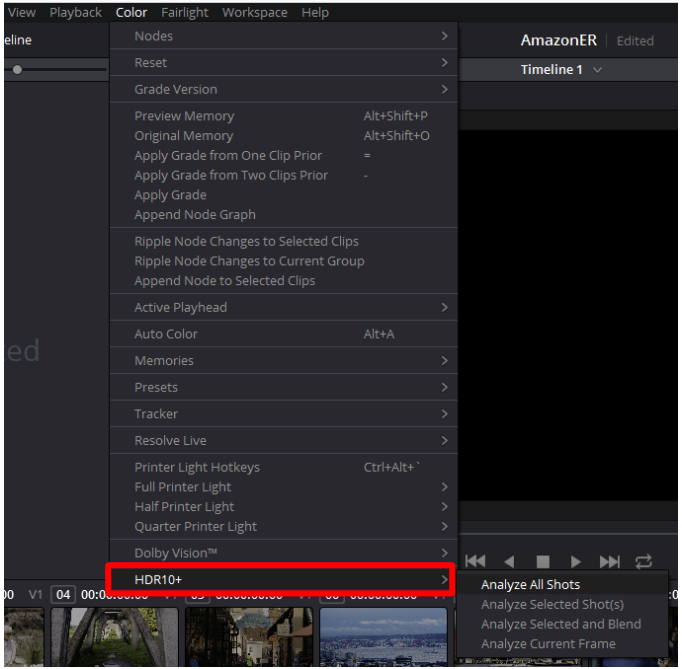
- **Metadata generation is easy.**
- **Metadata can be easily validated for HDR10 and HDR10+ at same time**
- **This is similar QC process**

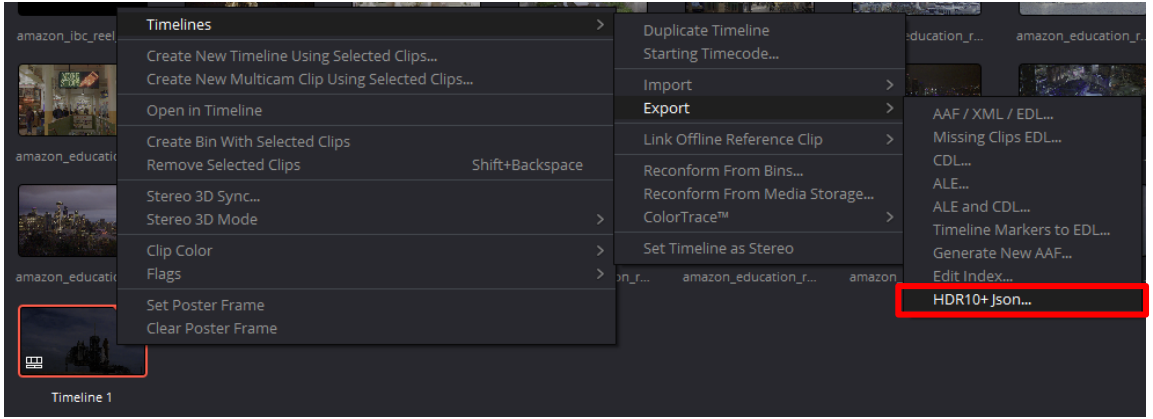
(Image courtesy Amazon Studios & ColorFront)

PR: Black Magic Design – NAB 2018

Launched HDR10+ support in Resolve 15

- **PR Quote:** *Support for native HDR10+™ controls in Da Vinci Resolve Studio*





Scenarist & ATEME Blu-ray HDR10+

HDR10+ support: Demonstrated Deluxe authored HDR10+ UHD Blu-ray disc playback across HDMI at NAB

SCENARIST
THE BUSINESS OF AUTHORING

Home Products Support Contact Press Purchase

Samsung, Deluxe, ATEME and Scenarist Deliver End-to End HDR10+ Production Workflow for Ultra HD Blu-ray

Technology Companies Complete HDR10+ Ecosystem in Hollywood

Apr 4, 2018

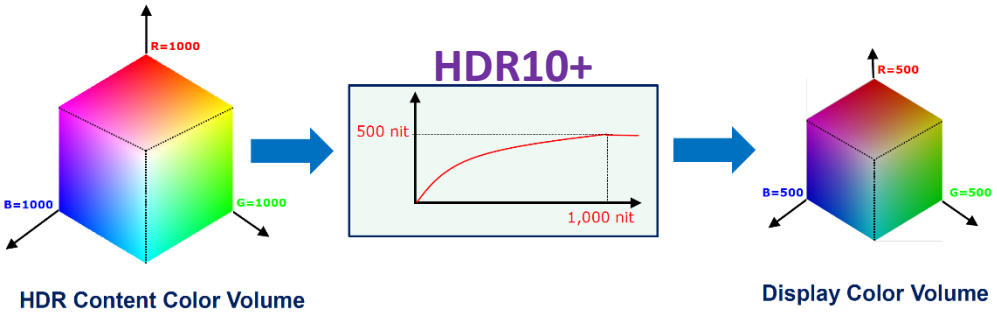
(Image courtesy Scenarist)

Summary

- ***HDR10+ Tools ready***
  - ***Mastering***
  - ***Post Production***
  - ***Encoding***
  - ***Authoring***
- ***Upgrade path for HDR10 content***

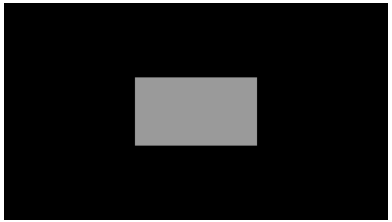
Important HDR10+ Technology Features

- Scene based statistics
- Option for preview of result (professional uses)
- Samsung implementation provides for superior content to TV adaptation
- Our solution covers tone mapping and TV makers performs panel adaptation to finalize the processing.



Improved scene statistics over HDR10

- MaxCLL is fine for use as a static “target”, but is too sensitive for dynamic use.
- HDR10+^{LLC} fixes to 7 percentiles:
  {1%, 25%, 50%, 75%, 90%, 95%, 99.98%}.
- This solution is robust and tolerant of spurious pixels. (random extremely bright pixel/s)
- Two new parameters are stored in the percentile vector to follow 2094-40 syntax:
  - {1%, llc, llc, 25%, 50%, 75%, 90%, 95%, 99.98%}

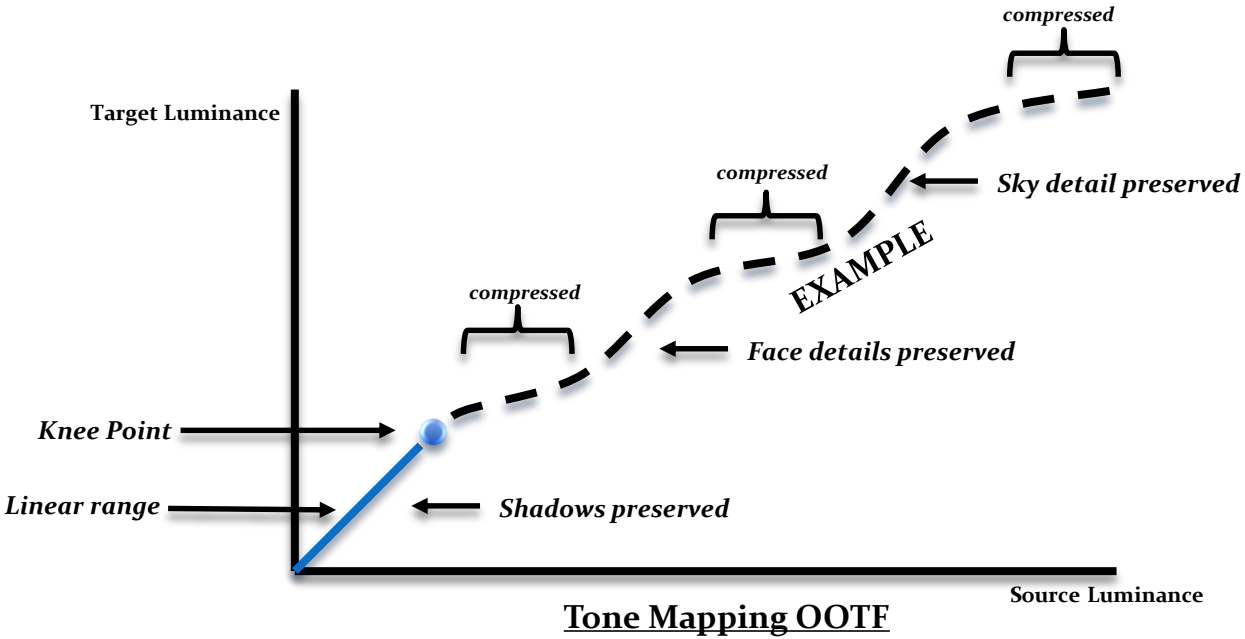


Example 11% 250 nits:

- Results in 90%, 95%, 99.98% as “250”

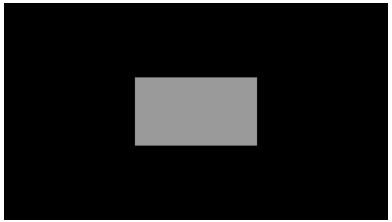
Guided Tone mapping with Bezier curve technology

- The Bezier curve allows smooth, yet nuanced, mapping
  - Critical tones can be preserved
  - “In-between” areas can be compressed
  - Provided in metadata (can be creatively controlled)



Bezier anchor points can be provided

- Calculated at same time as statistics
- Can be creatively controlled or created.
- Used in all Samsung TV implementations
- Available from Samsung royalty free to SoC and TV makers

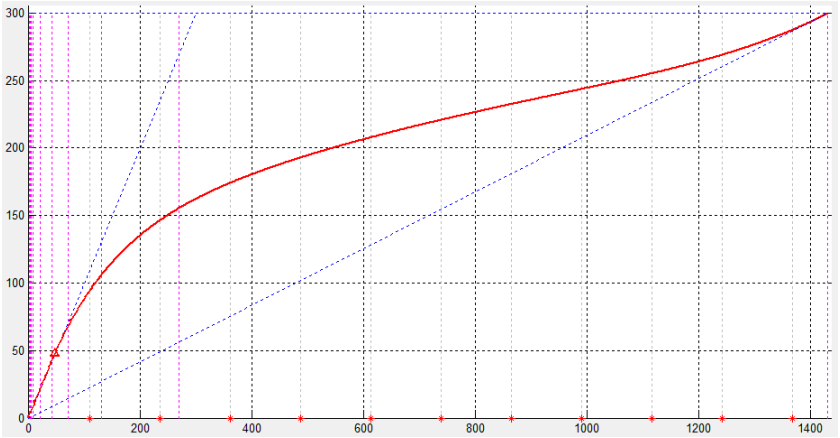


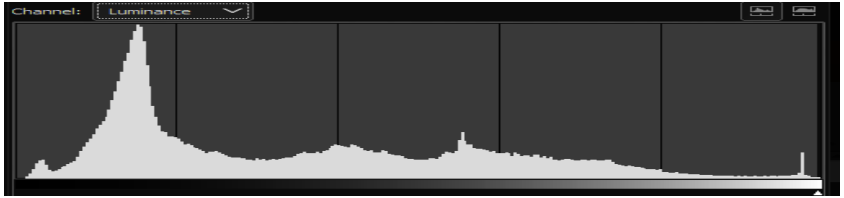
Example 11% 250 nits:

- Results in straight line guide curve (aka “Bypass”)

Bezier Curve

- **Example :** Bezier Curve

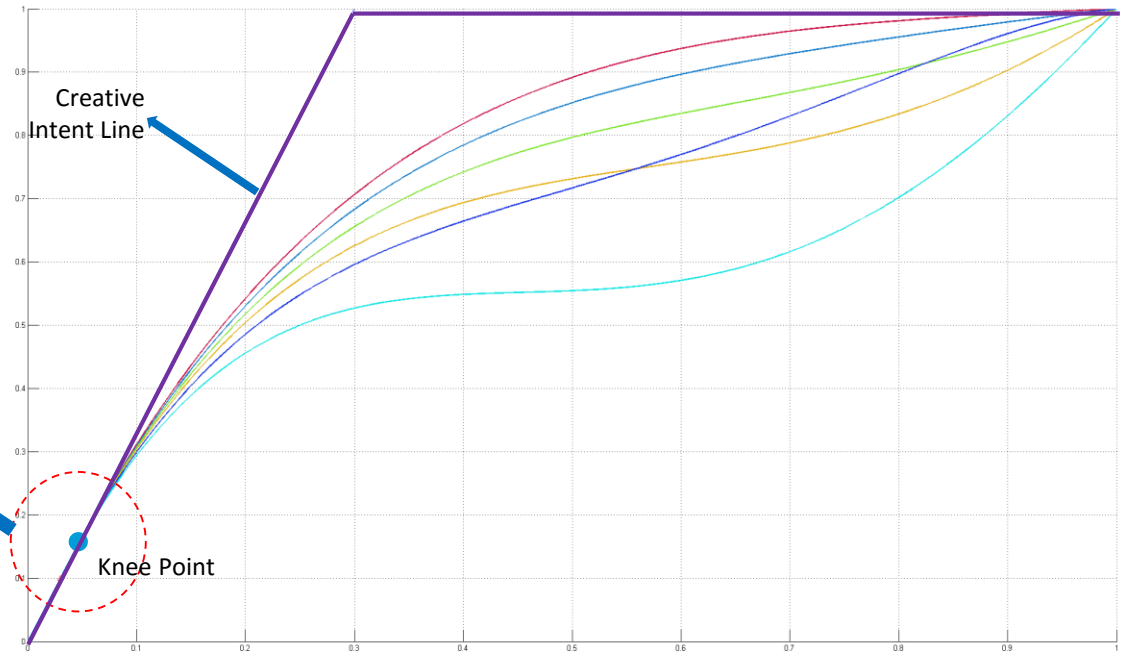




Why Bezier Basis Guided OOTF

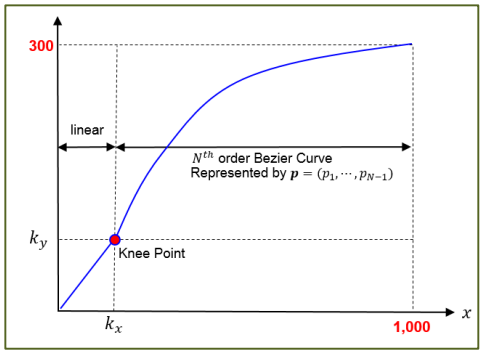
❑ Continuity of slope : Bezier Curves

We can make the slopes continuous and preserve the creative intent in shadow area.



Device Implementation: Guided OOTF

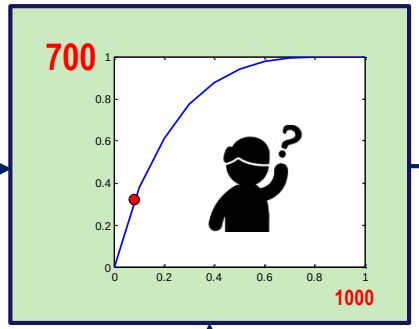
- Transmit the basis curve and mix with product!



Basis OOTF(1000,300) is transmitted to device

OOTF(1000,300)

OOTF(1000,700)?



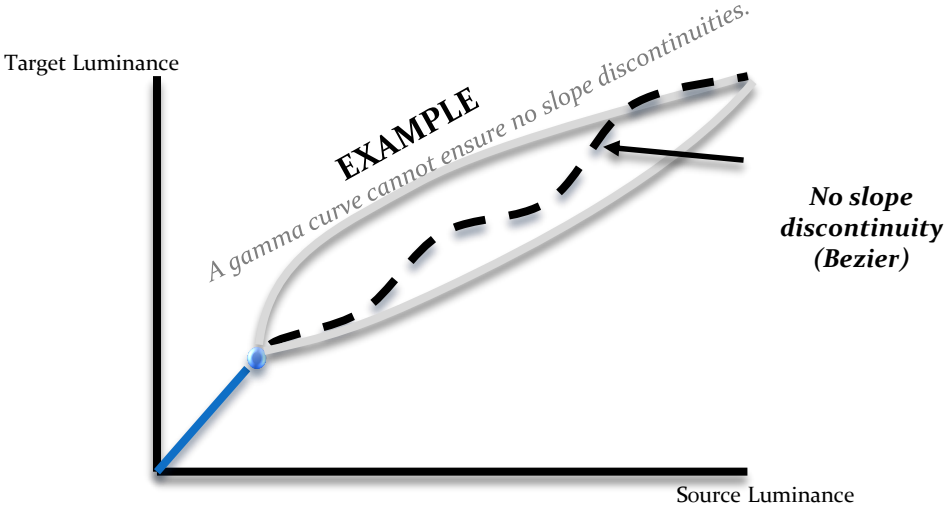
Product Display
(P=700 nit)

Basis OOTF Metadata:
$(\boldsymbol{k} = (k_x, k_y)\,, \mathbf{p} = (\mathrm{p}_1, p_2, \ldots, p_{N-1}))$

Metadata Parser

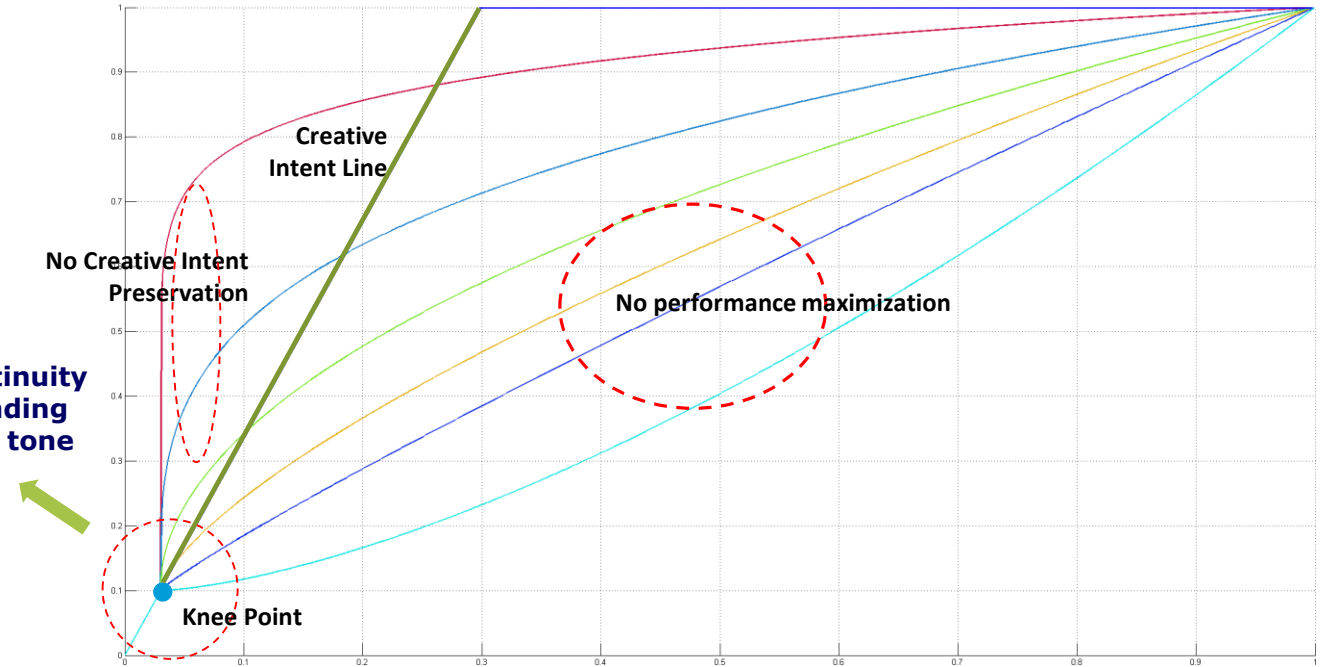
Bezier vs Gamma

- The Bezier curve allows avoidance of slope discontinuities
- Slope discontinuities can cause sharp contour artifacts
- Tone mapping in display should not be done using gamma as it is very coarse



Tone Mapping OOTF

Gamma based adaptation is difficult



This slope discontinuity can introduce banding artifacts after the tone mapping

Summary

- Maximizes creative intent across various displays
  - Enables content-specific mapping, avoids over aggressive static tone curves commonly found in displays
  - Shadows fully preserved
  - Ensures a low-APL baseline (e.g. will track PQ on low APL images)
- Minimizes artifacts
  - Hard slope changes can be avoided
- Improves robustness of statistical measurements over static
  - Tolerant of spurious pixels
- Workflow compatible
  - Manual or Automatic metadata generation for offline or live use cases
- Deployment is being established across HDR ecosystem
  - Tools, Software, SoC, and Display