

HDR (High Dynamic Range)

Technical Considerations for Live Production and Distribution Workflows

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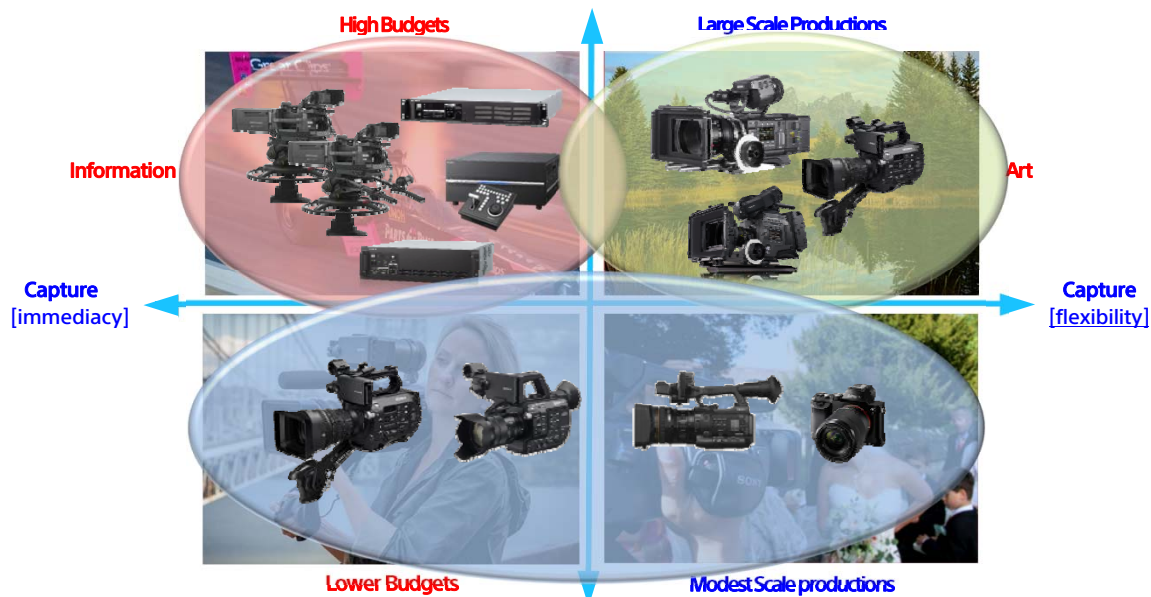
HDR Session Agenda

- **HDR Applications Map and Content Production Techniques**
 - Cinema Studio/Production
 - Sports/Broadcast Live
 - Independent/Small Productions
- **HDR Standards for Distribution Applications**
- **SR Live: HDR workflows for Live Applications**
 - S-Log3_Live and HLG_Live for Production Mastering Formats
 - AIR Matching for Home Viewing of Rendering Intent
- **Video Compression of HDR signals**

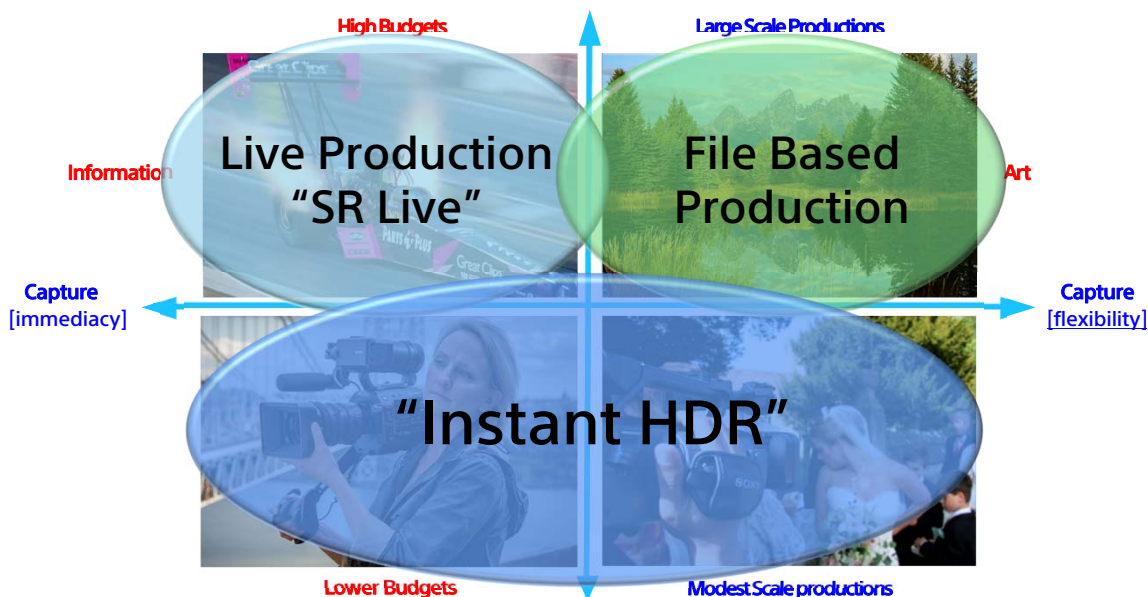
HDR Applications Map



HDR Applications Map



HDR Applications Map



Sony Expansion of HDR production techniques

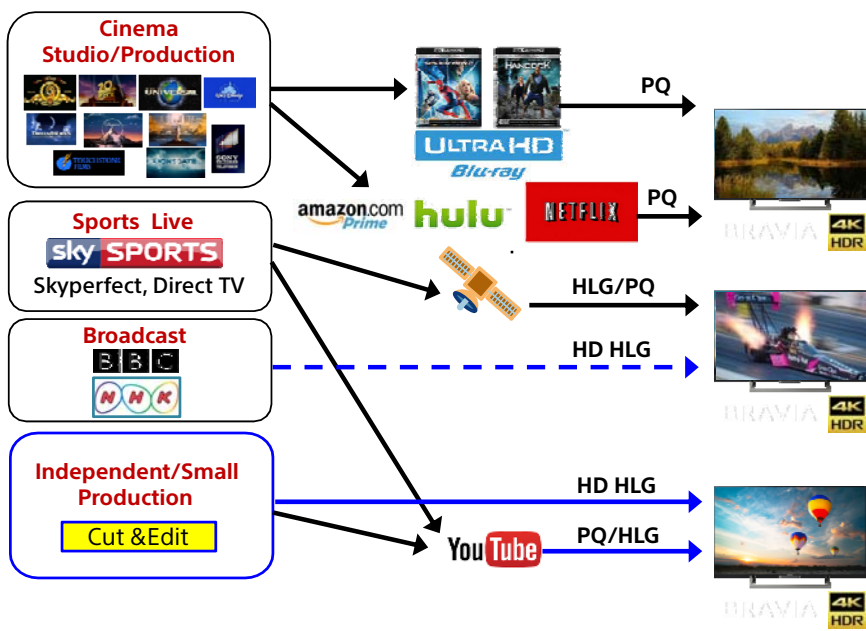
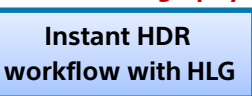
File-based Production



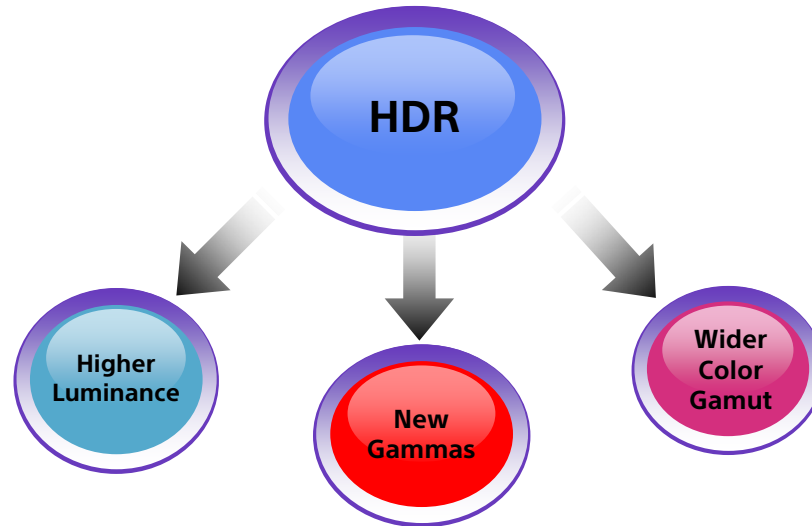
Live Production



Corporate/Event Videography



Components of an HDR Image



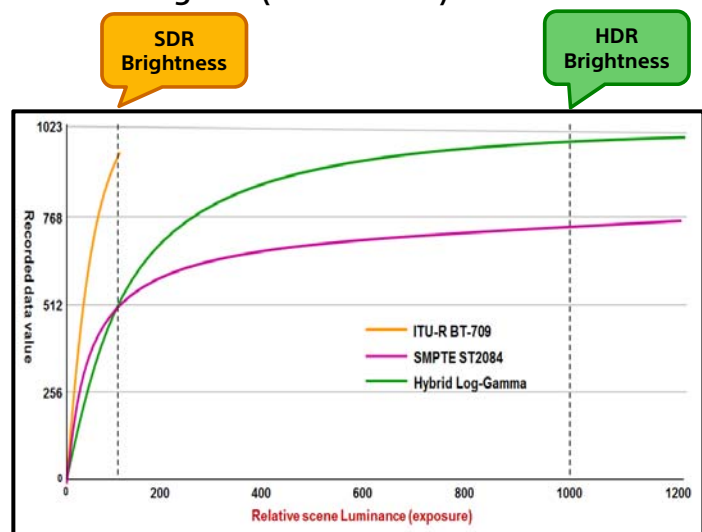
New 'Gamma' curves for HDR signals

- Input/output curves for transmission of HDR signals (OETF/EOTF)

- "PQ" (SMPTE standard ST.2084)

- "Hybrid Log-Gamma" (HLG) developed by BBC/NHK

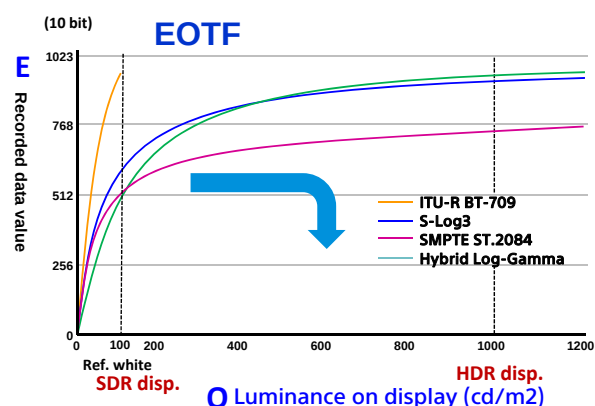
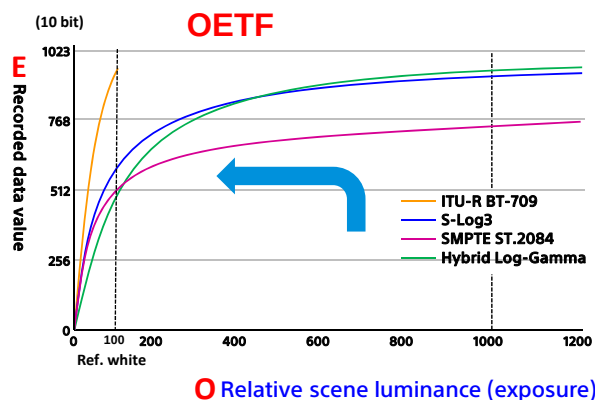
- Both techniques also standardized in ITU-R BT-2100-1



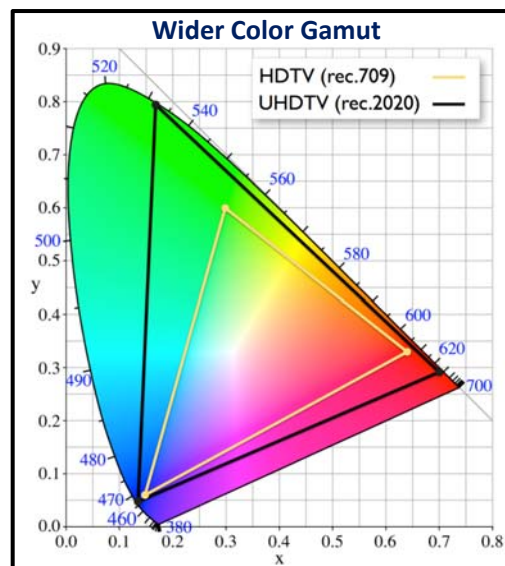
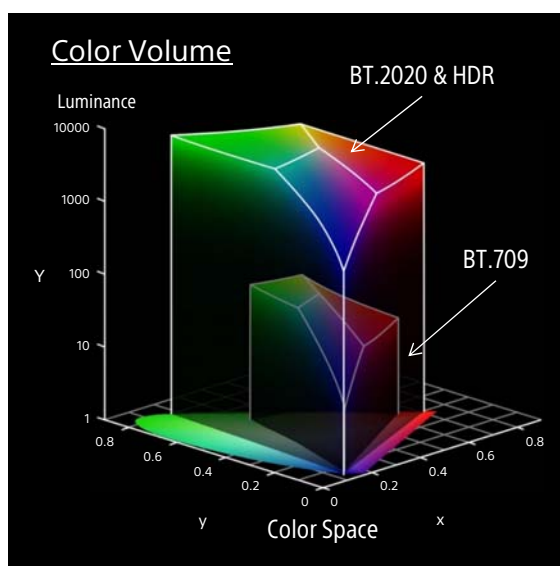
What is OETF/EOTF?

Opto-Electrical and Electro-Optical transfer functions

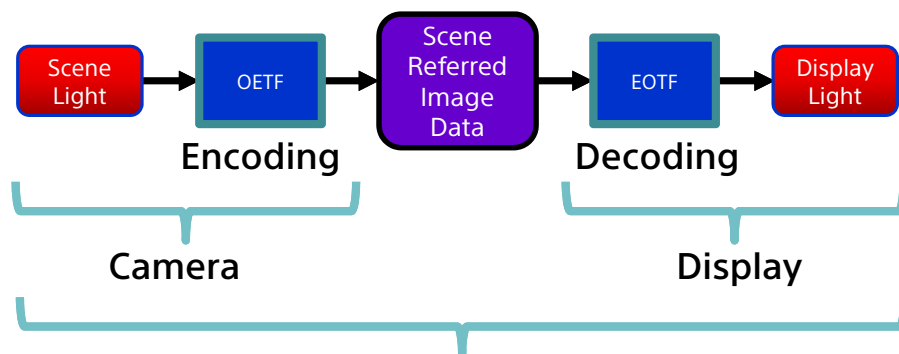
- OETF describes the action of the sensor, converting from scene brightness to data.
- EOTF describes the action of the display, converting from data to screen brightness.



Color Volume with Wide Color Gamut & HDR



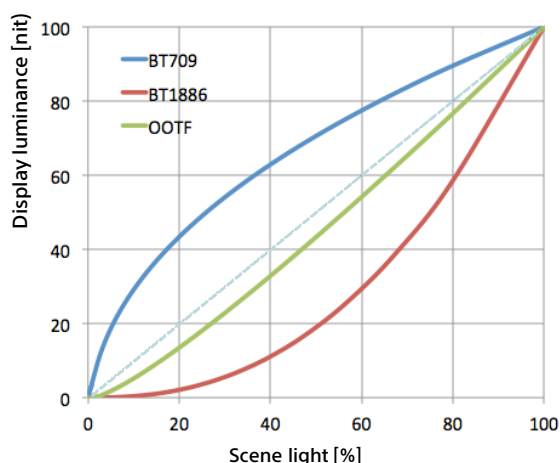
End-to-End Television Signal Chain: OOTF



Opto-Optical Transfer Function (OOTF)

OOTF : Transfer function to convert the actual scene light to display luminance; varies according to viewing environment and brightness of the display

OOTF (System Gamma) in HD SDR



BT.709 (Camera)

Transfer Function to Display $\approx 1/2.2$

BT.1886 (Display)

Display gamma for flat panel display = 2.4 (2011)

OOTF
Opto-Optical
Transfer Function
(System Gamma)
= 1.2

is known as good picture in current TVs

When viewing the images on a flat screen display, such as LCD, Plasma, without OOTF, it appears as if the black level is elevated a little.

In order to compensate the black level elevation and to make the reproduced images look closer to those on a CRT, a display gamma for flat panel display = 2.4 has been defined under BT.1886.

As a result, OOTF = 1.2 has been adopted.

Current broadcast system uses an OOTF (System Gamma) of 1.2

Overall Transfer Function (OOTF) Non-Linear

Opto-Optical Transfer Function (OOTF)

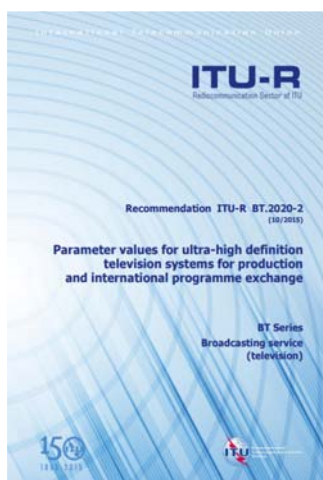
Also known as:

Overall System Gamma

Artistic Rendering Intent

ITU-R BT.2100-1
International Standard for an
HDR UHD System

Standards (Production & Program Exchange)



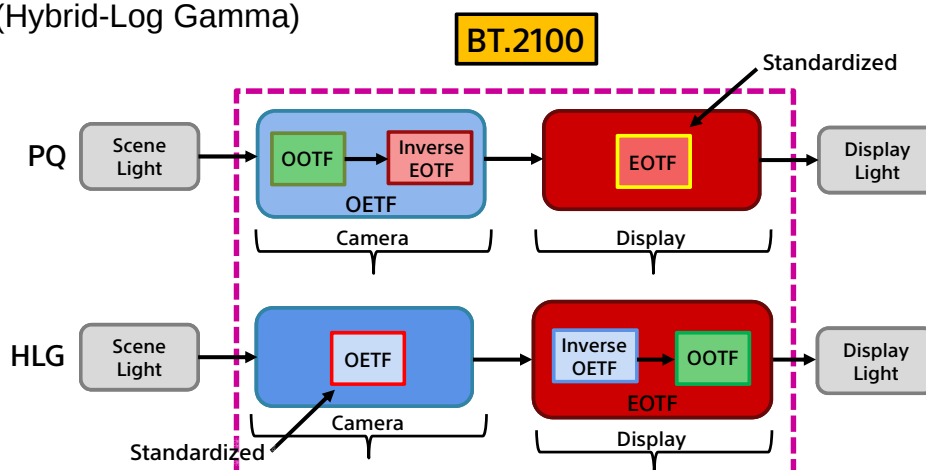
ITU-R BT.2020
Ultra HDTV Parameters



ITU-R BT.2100
HDR Parameters

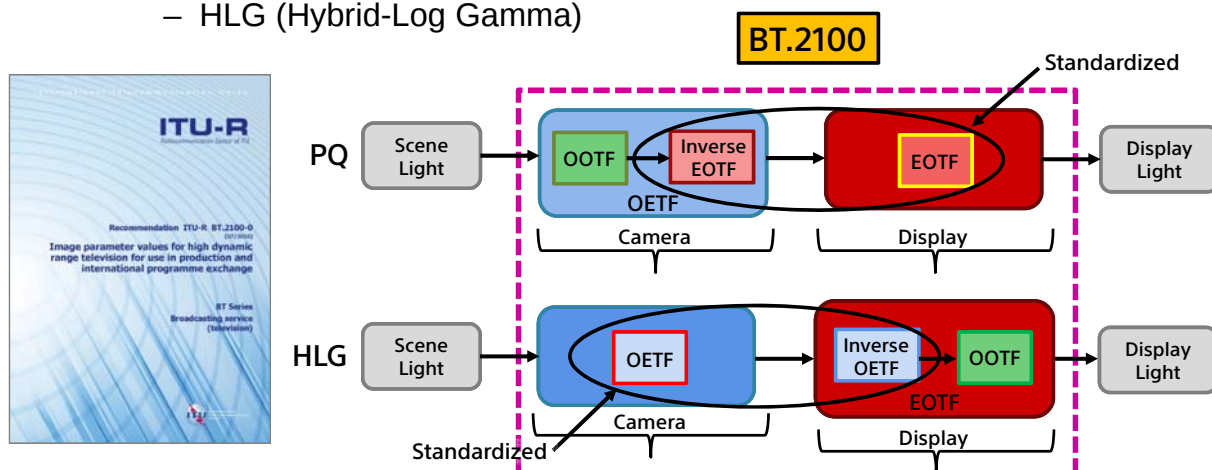
Two specifications defined for HDR in ITU

- Recommendation ITU-R BT.2100-0 (07/2016)
 - PQ (Perceptual Quantization)
 - HLG (Hybrid-Log Gamma)



Two specifications defined for HDR in ITU

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Summary

Item	Parameters
Format	HLG, PQ
Spatial Resolution	HD: 1920 x 1080 4K UHD: 3840 x 2160 8K UHD: 7680 x 4320
Color Space	BT.2020
Bit depth	10bit, 12bit
Frame rate	120, 120/1.001 (119.88), 100, 60, 60/1.001 (59.94), 50, 30, 30/1.001 (29.97), 25, 24, 24/1.001 (23.98)
Scan	Progressive Only

Comparison of PQ & HLG solutions

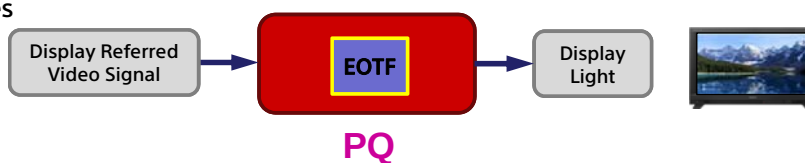
HLG is "Scene-Referred"



- Like BT.601, BT.709, Slog3, PanaLog, etc., the HLG signal describes the **relative** light in the scene.
- It is specified by the OETF (Opto-Electronic Transfer Function), the camera characteristic

PQ is "Display-Referred"

- Like the digital cinema standards, the signal describes the **absolute** light output from the mastering display.
- The signal is specified by the display EOTF



And PQ and HLG work differently

- **HLG**

- Image brightness changes with display brightness
- Dynamic range of highlights **constant**
- **Brighter displays for brighter environments**

- **PQ**

- Image brightness is constant with display brightness
- Dynamic range of highlights **increases** with display brightness
- **Brighter displays for more highlights**

HDR Live Workflow

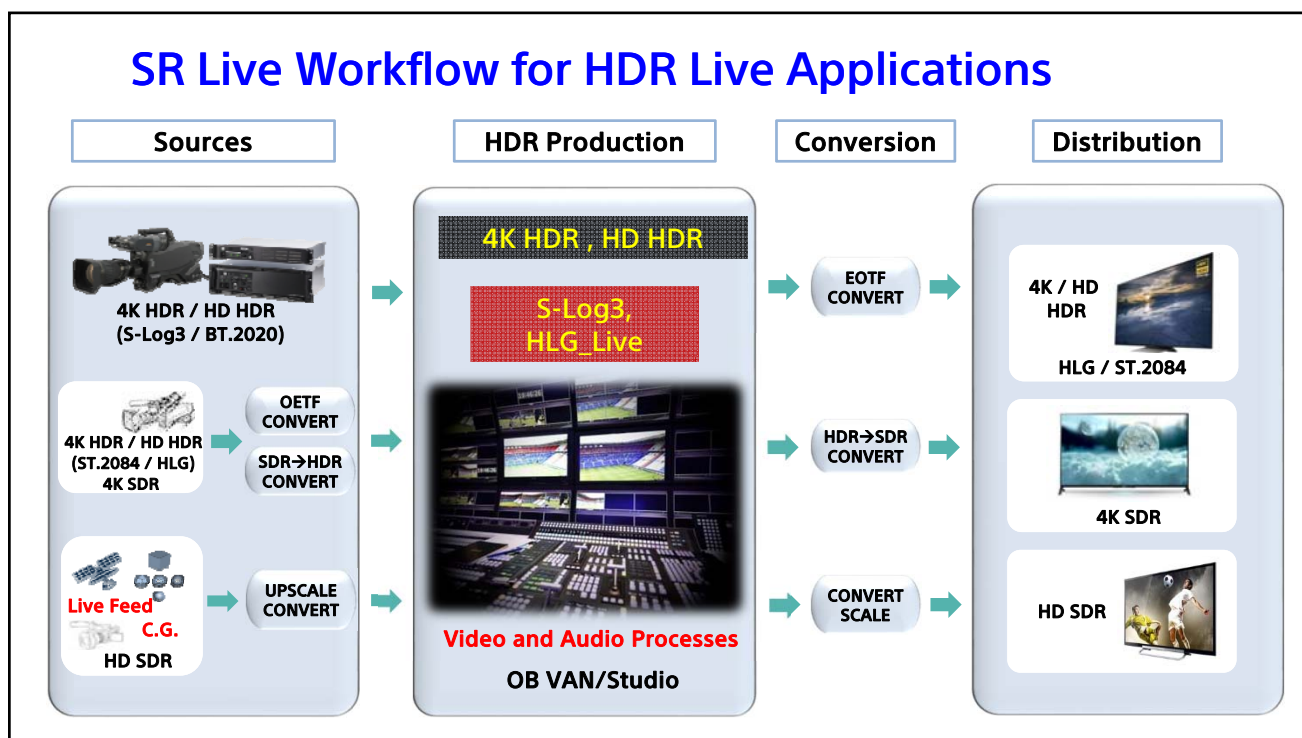
"Scene Referred Live Workflow"



SR Live for HDR Live Production Workflows

1. Efficient utilization of infrastructure and personnel to enable uncompromised production of **HDR and SDR video signals simultaneously**
2. To enable camera shading and painting operations, based on **well experienced and/or skilled techniques**, on HD-SDR monitors/WFM's
3. Creation of best production live HDR images, which can be easily converted to distribution standards on an **"As-Seen" basis**. Use of BT.2100 compliant delivery formats: HLG or PQ
4. Full artistic control on content rendering intent from production to home

SR Live Workflow for HDR Live Applications



HDR and SDR from a single camera system

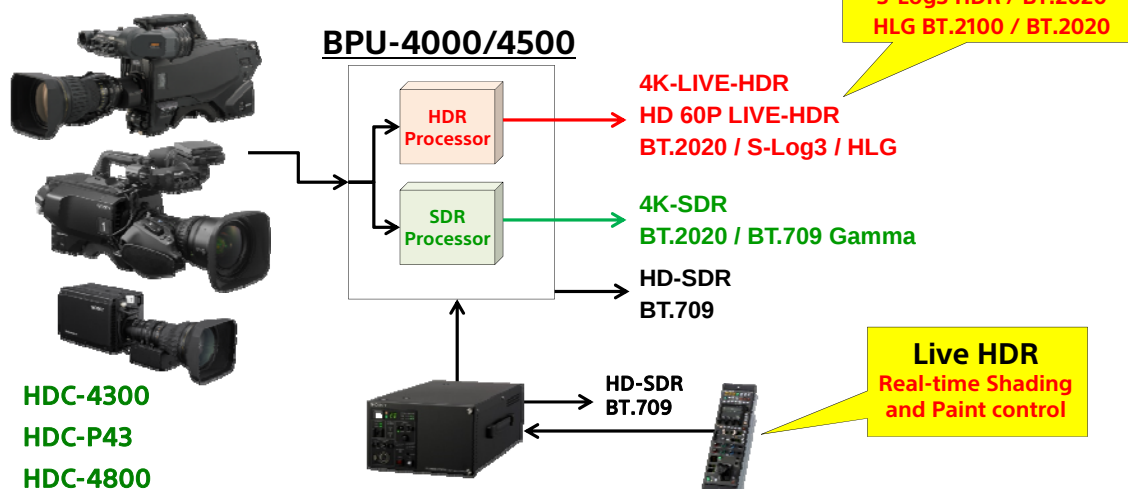
4K/HD HDR & HD SDR Simultaneous Production



Very best 4K/HD HDR / HD SDR and skilled Artistic ("Creative") Intent for HD SDR

Sony's 4K/HD HDR Live System

4K/HD **HDR** & HD **SDR** Simultaneous Production



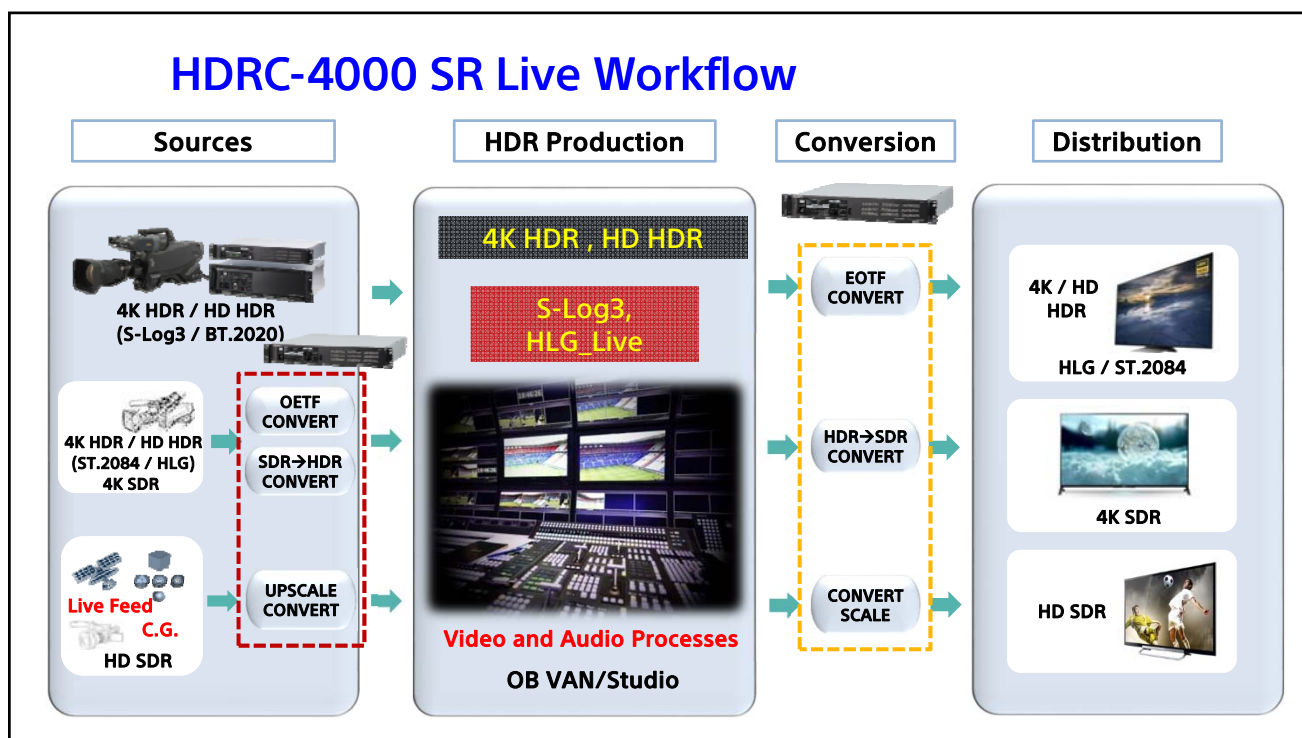
Precision Conversion and Format Processing



- Multi format conversion
 - 4K ↔ HD
 - HDR ↔ SDR
 - HDR ↔ HDR, S-Log3/HLG/PQ
 - BT.2020 / BT.709

- 12G-SDI / 6G-SDI support
- 2x4K or 8xHD; HD input x 4 mode
- MSU/RCP Configuration (file export/import)
- 'Display Referred' Function
- 6 channel embedded audio

HDRC-4000 SR Live Workflow



Accurate Monitoring/HDR Image Reproduction



BVM-X300

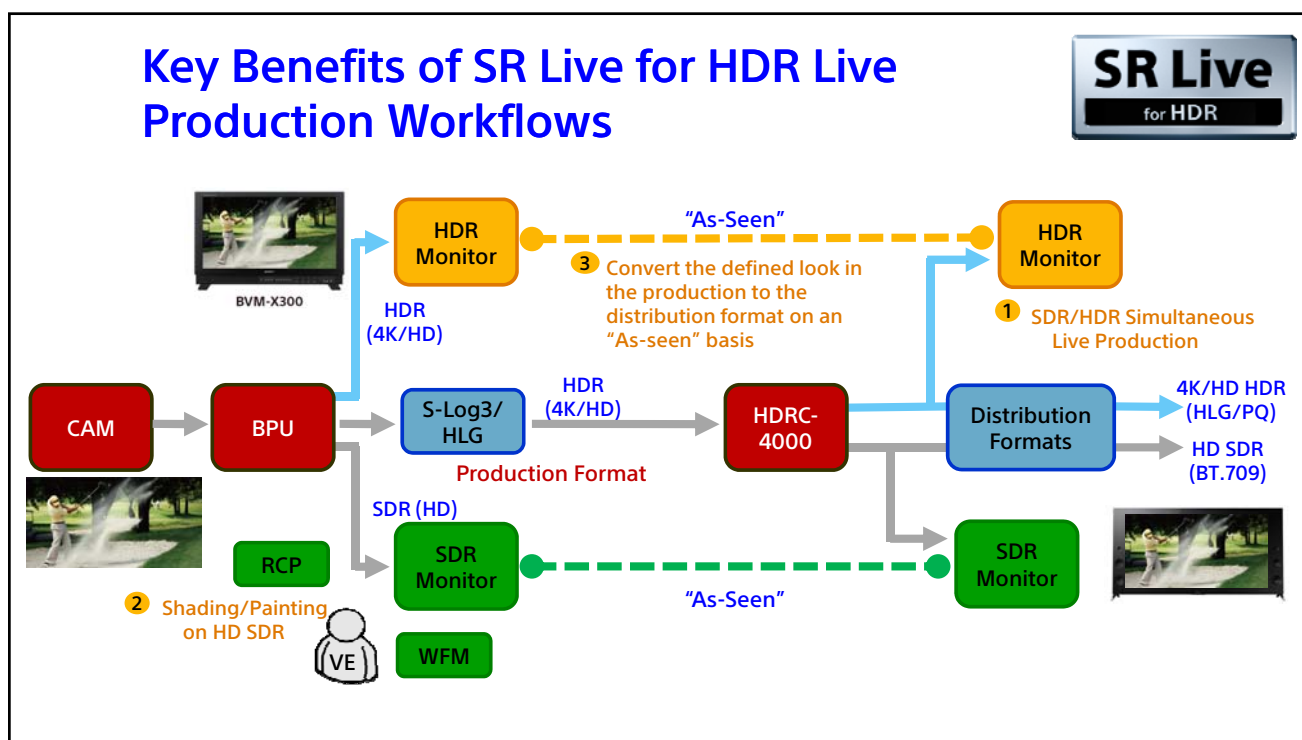
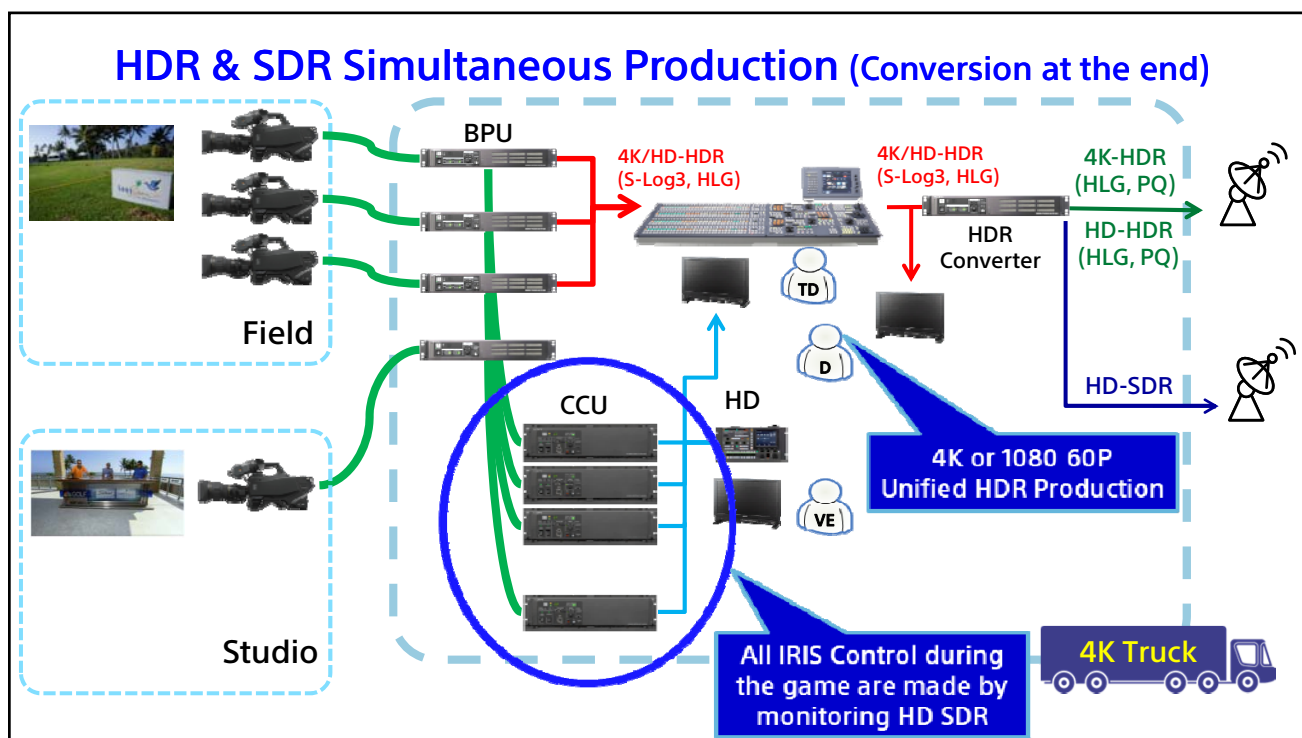
Supporting various EOTF's

- SMPTE ST 2084 (HDR)
- HLG BT.2100 (HDR)
- S-Log3/HLG (Live HDR)^(*)

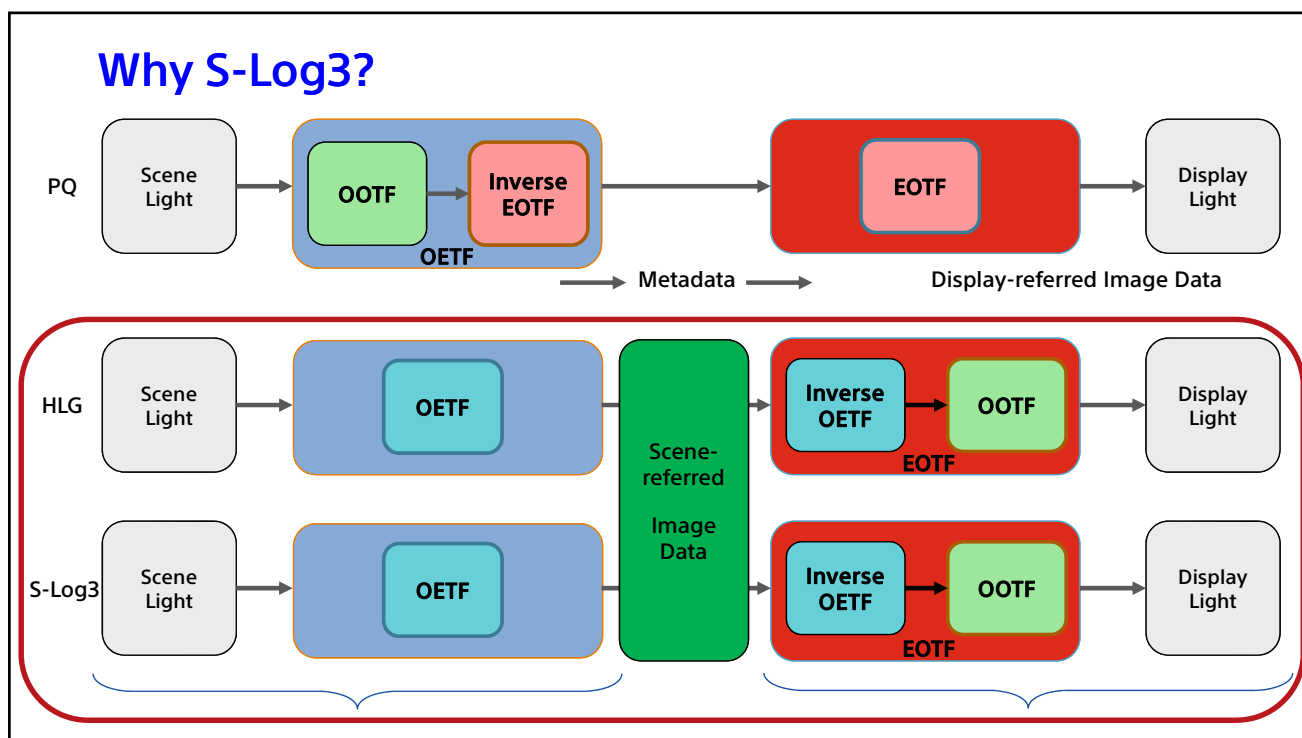
^(*) **S-Log3 / HLG (Live HDR)**

When [S-Log3/HLG (Live HDR)] is selected, BVM-X300 reproduces an S-Log3/HLG HDR image with System Gamma (or OOTF), in order to use this monitor as the reference for S-Log3/HLG Live HDR workflow, which Sony is proposing.

This System Gamma is optimized for HDR image creations and expressions. It is designed based on well-established camera control techniques for the current HD (SDR) imaging and monitoring.

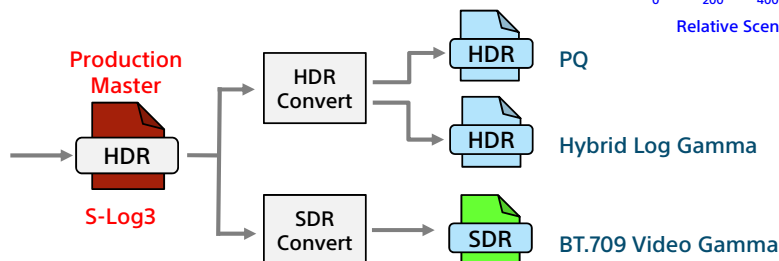
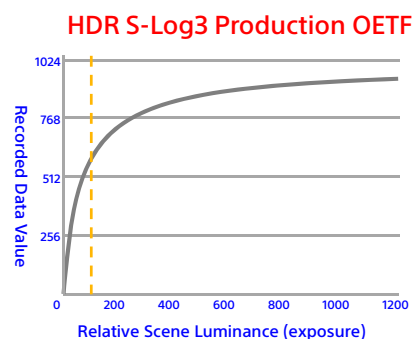


Why S-Log3?

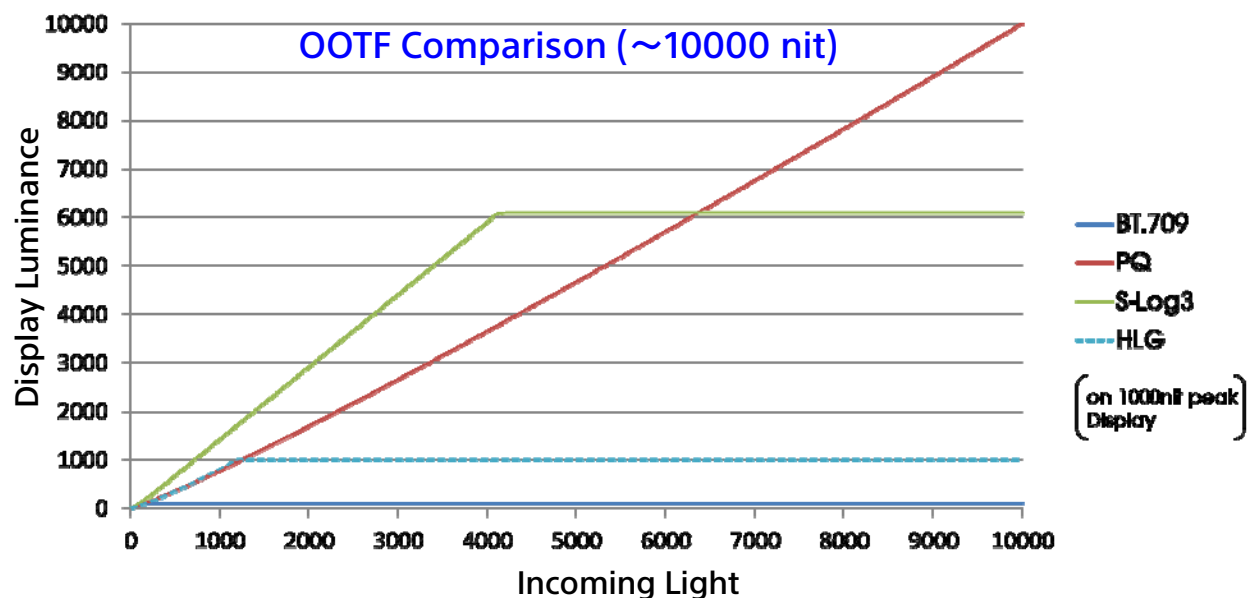


SR Live System: What is S-Log3 ?

- S-Log3 is the OETF used to derive the best performance of Sony camera's image reproduction capability
- Most suitable OETF for Color Grading Process under the condition of current 10-bit interfaces
- Excellent production master format when program is transformed to other distribution Gammas



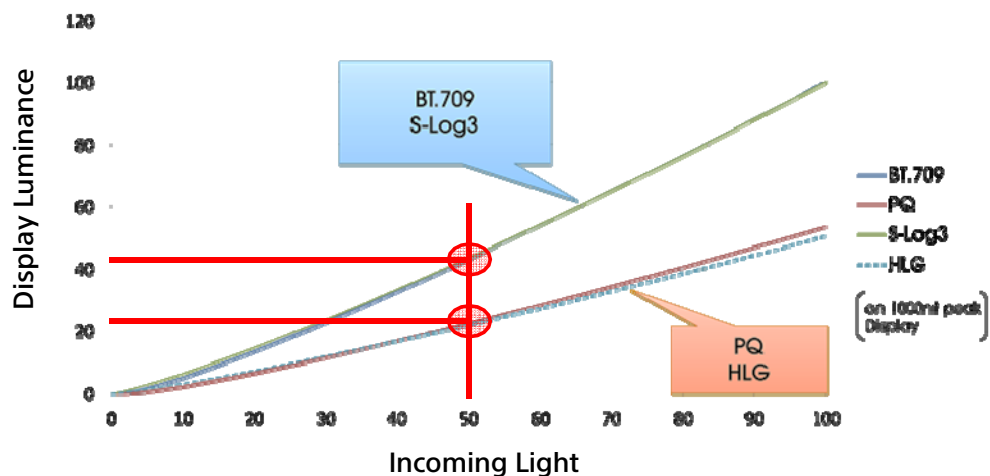
OOTF Performance



OOTF Performance (cont'd)

OOTF Performance of HDR OETF curves in SDR input signal range (0-100%)

OOTF Comparison (~ 100nit)



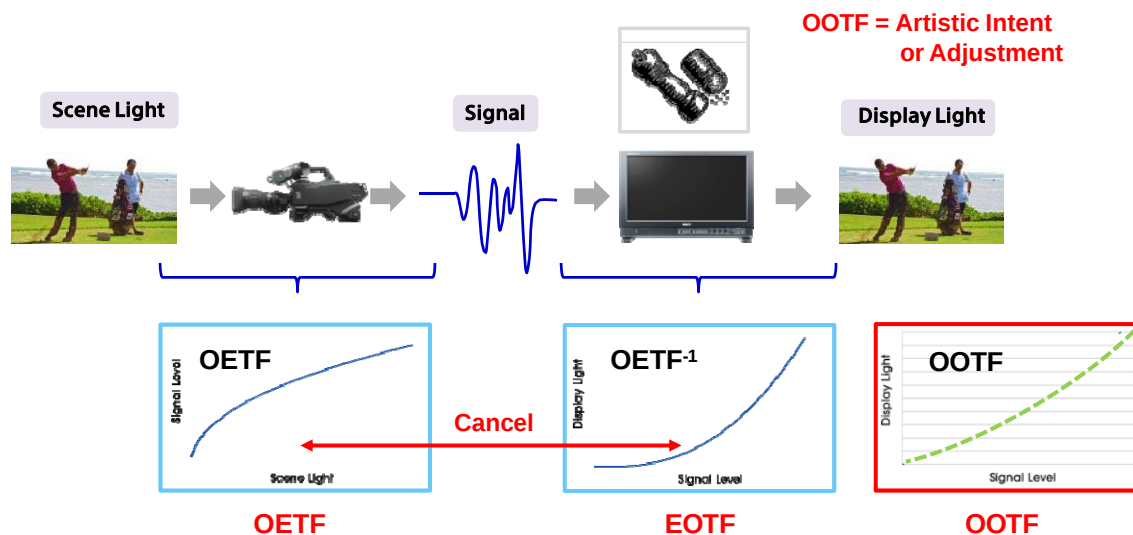
AIR Matching Function

Special Feature – AIR Matching Function

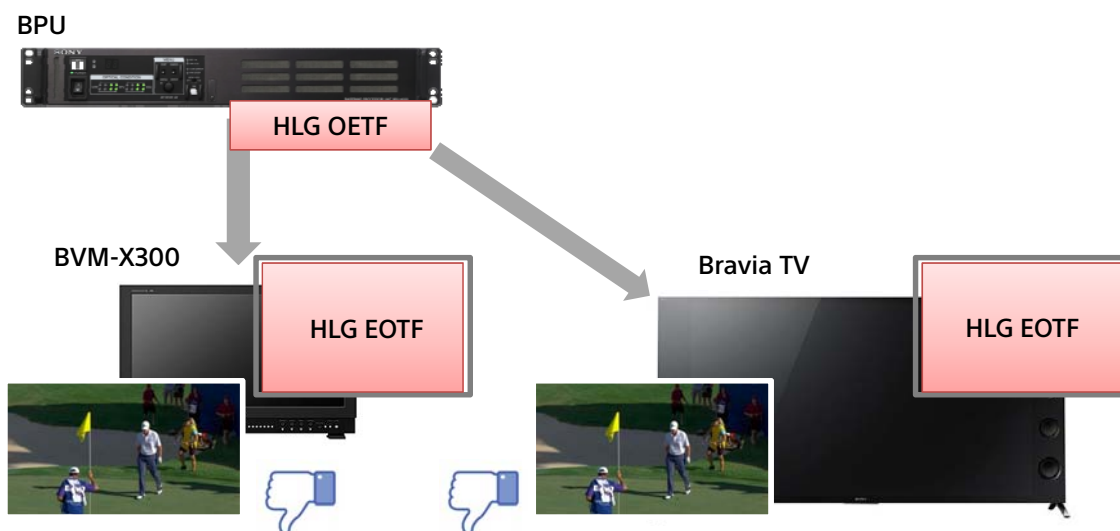
AIR: Artistic Intent Render



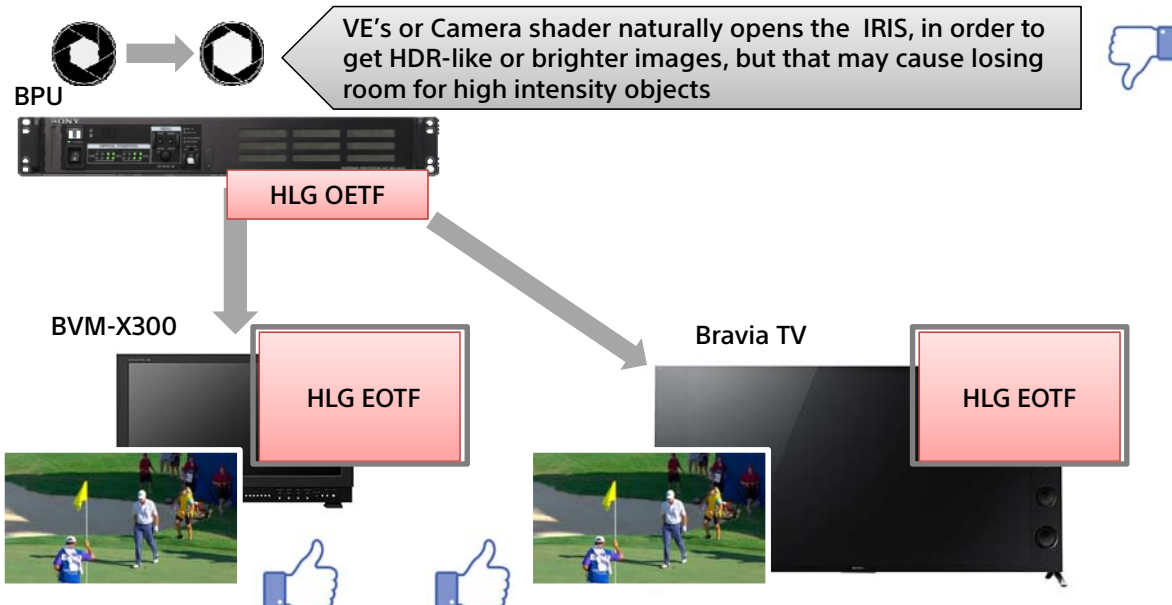
OETF – EOTF - OOTF



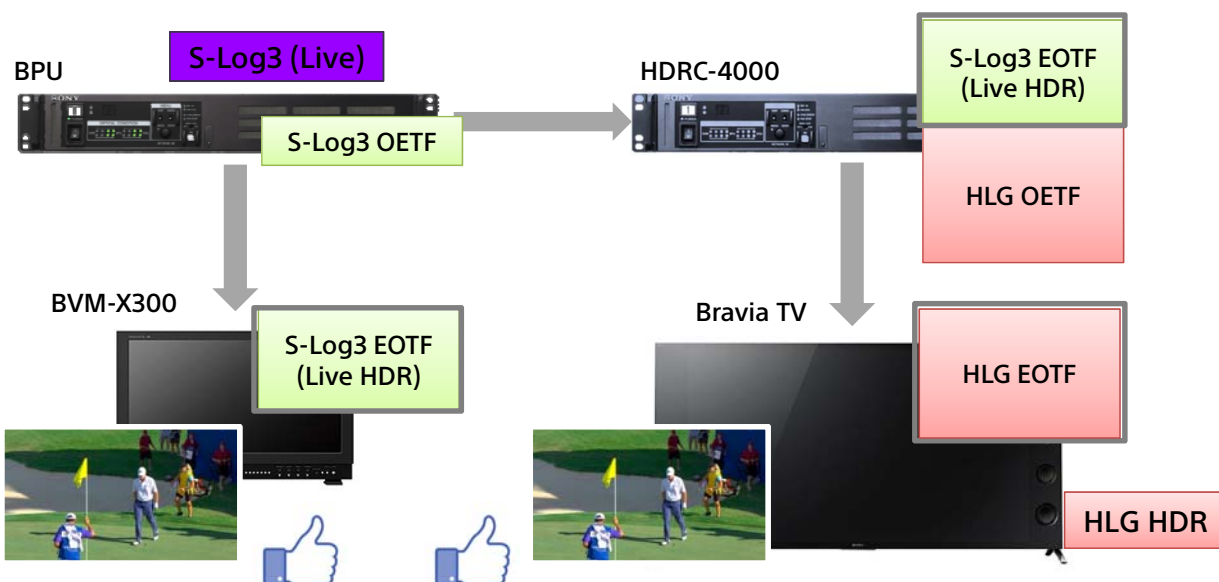
HLG End-to-End Processing: what is the result?



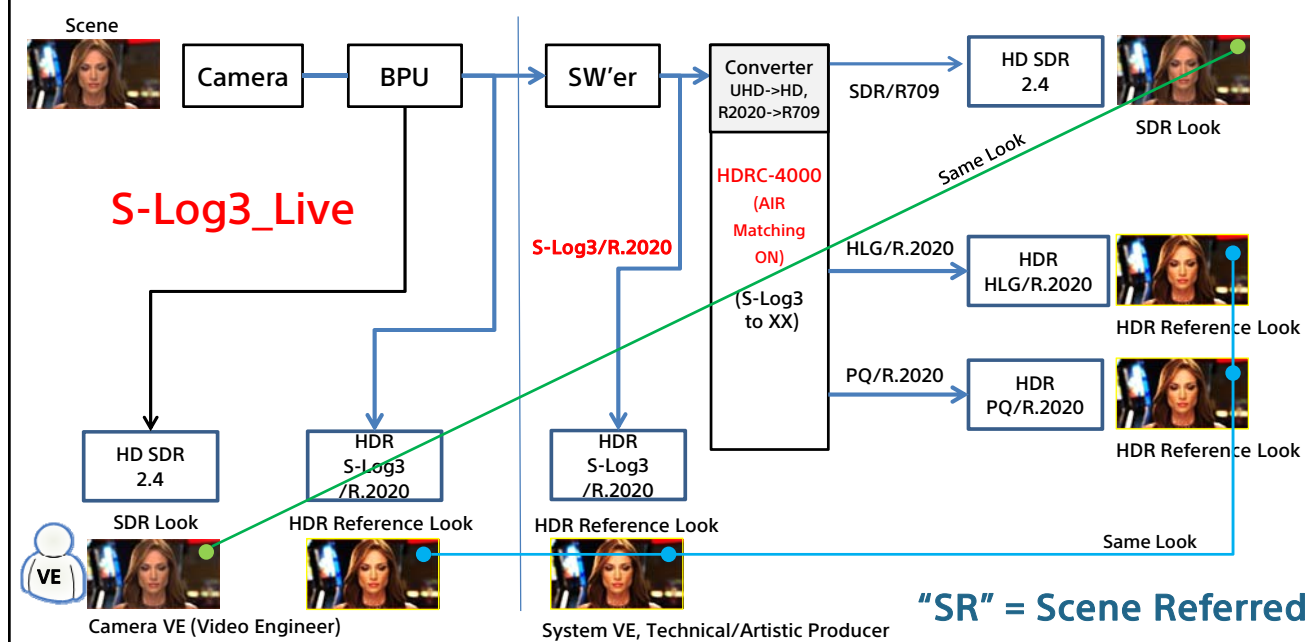
In order to gain HDR-Like Images:



Sony's S-Log3 (Live HDR) technique



Global Picture of "SR Live" for Live Productions



Worldwide HDR Live Production Events!



FIFA World Cup 2018



FIFA World Cup 2018

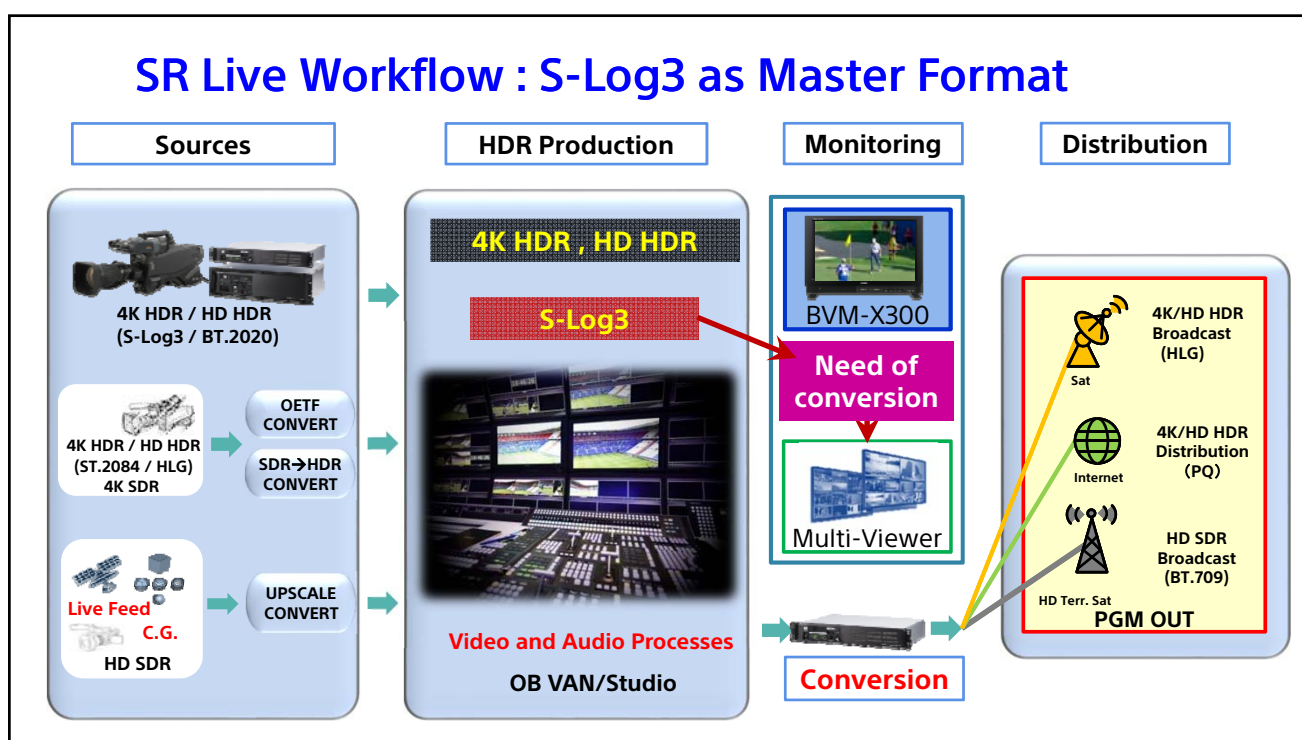
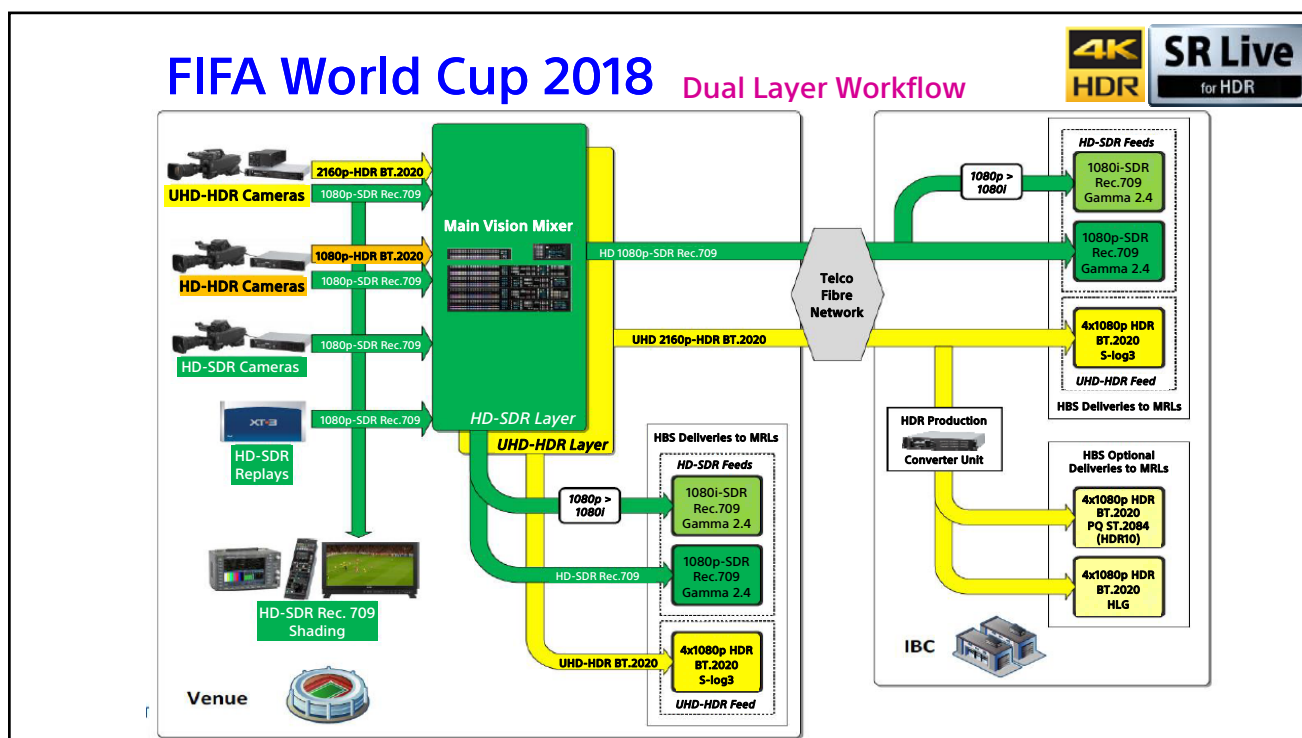


UHD/HDR Production

- 2 Layers
- Core layer 1080p/50 SDR REC.709 with HD Graphics
- Enhanced Layer UHD 2160p/50 HDR BT.2020 without Graphics
- Vision Mixer
 - 8 Cameras Dual output UHD/HDR and 1080p/SDR
 - 11 Cameras Dual output 1080p/HDR and 1080p/SDR
 - 21 Cameras Single output 1080p/SDR
 - All Replays 1080p/SDR
- Shading of all cameras is done on the 1080p/SDR layer

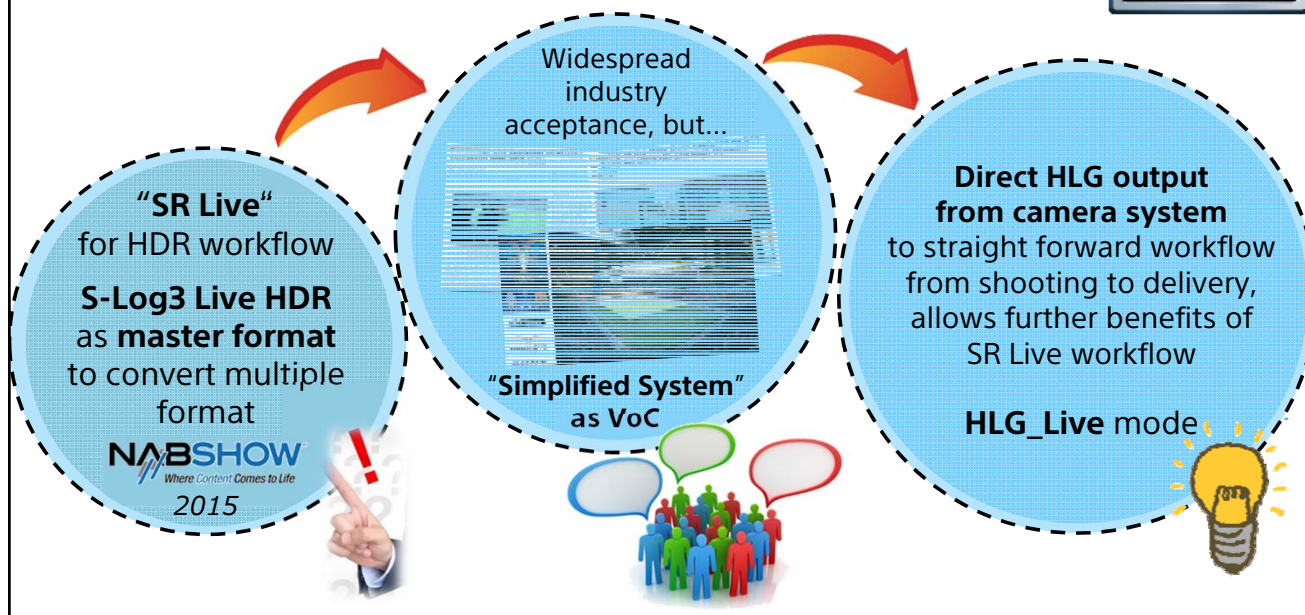
Standard Layer (HD / SDR)

- All cameras will operate in 3G 1080p50
 - Studio cams Sony HDC 4300
 - Special cams, RF, aerial
- SDR (OETF ITU-R-BT 709, gamma 2.4)
- Color space REC. 709
- Shading reference is REC. 709 and SDR Standard

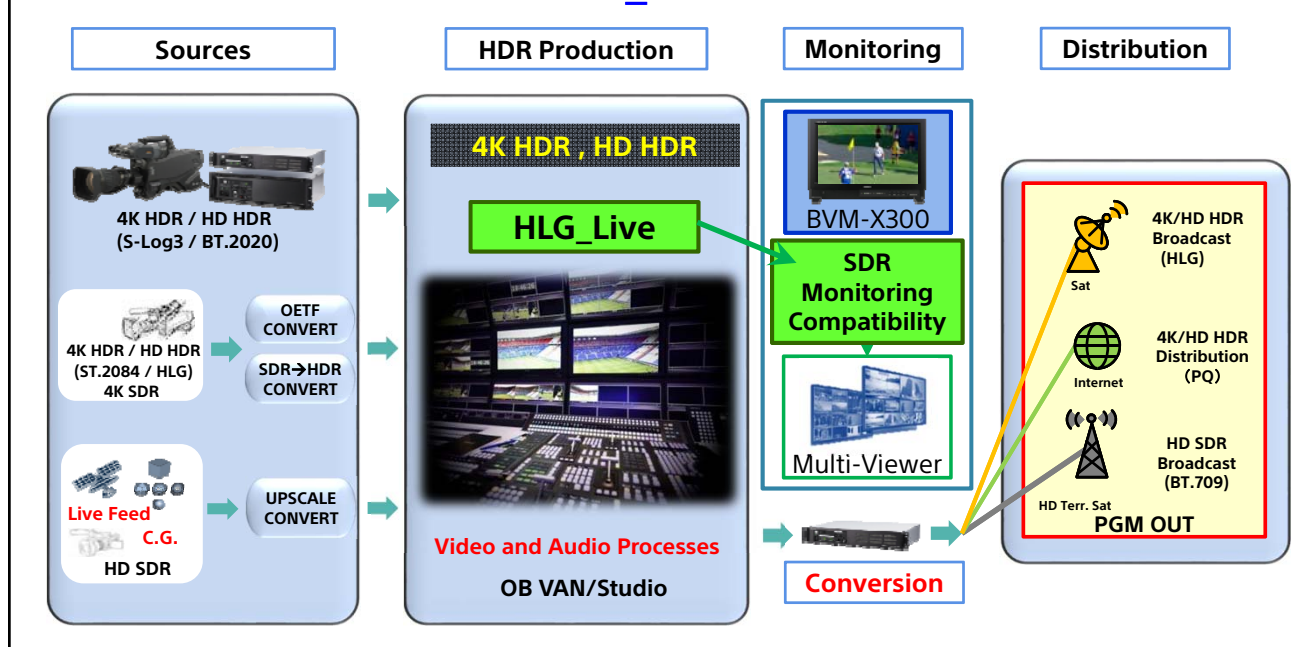


Introducing "HLG_Live" end-to-end solution

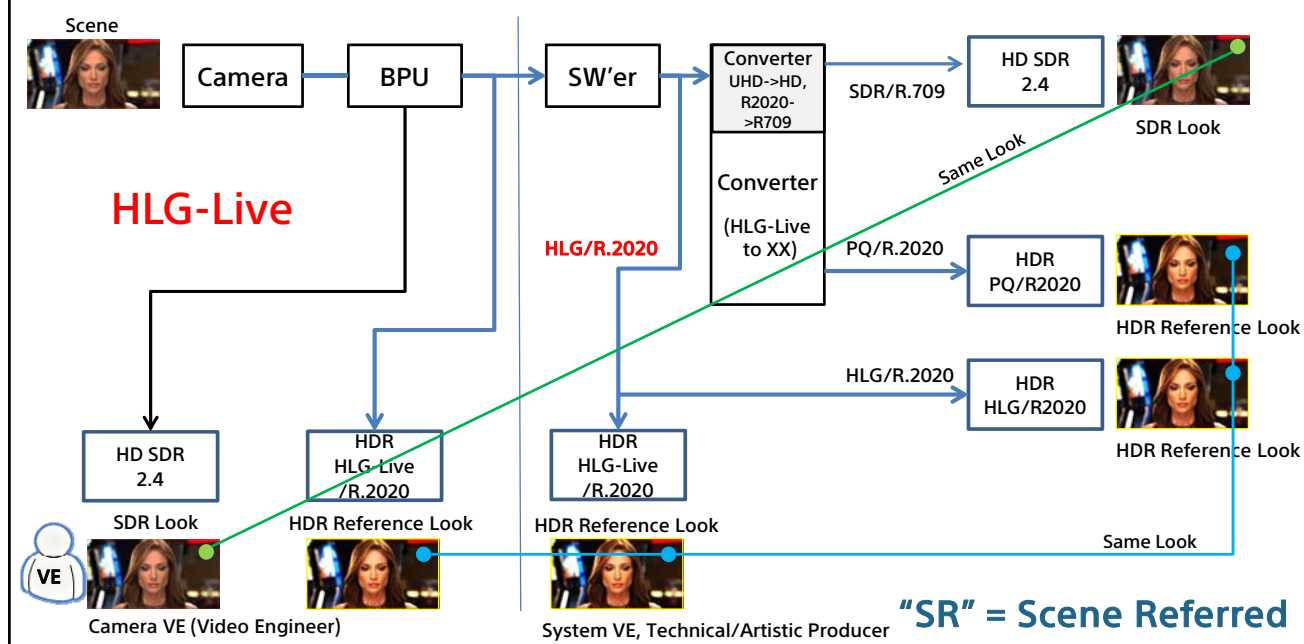
SR Live
for HDR



SR Live Workflow : HLG_Live as Master Format



Global Picture of "HLG-Live" for Live Productions



In Summary.....

3 Possible HDR OETFs created from Sony's BPUs

BPU-4000/4500



S-Log3 (Live)

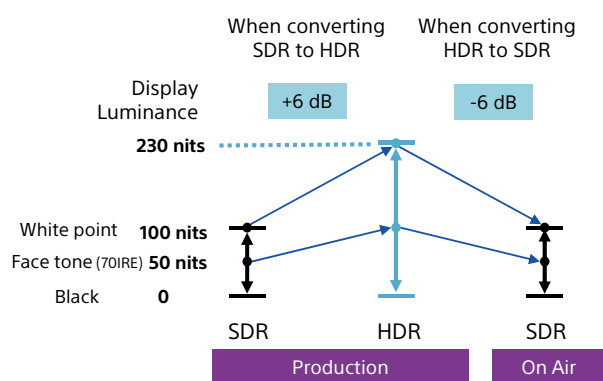
HLG_Live

HLG (BT.2100)

Some updates of Graphics and Text Levels in SR Live Workflows

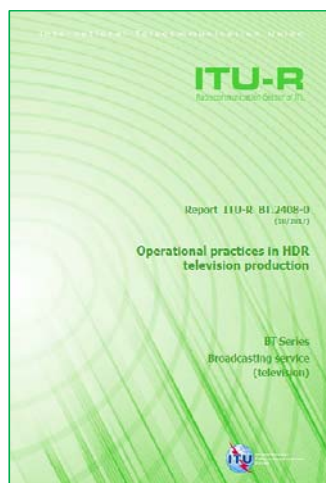
What level settings for SDR graphics?

Recommended Guideline for White Point



	Recommended Settings
SDR Gain	-6 dB
Display Luminance	230 nits
S-Log3 (Live HDR)	70 IRE (200)
HLG_Live	77 IRE (352)

HDR Production: Operational guidelines



ITU-R BT.2408-0 (10/2017)

Operational practices in HDR television production

Operational practices in HDR television production

Nominal signal levels for PQ and HLG production

Reflectance Object or Reference (Luminance Factor , %)	Nominal Luminance cd/m ² (PQ & 1 000 cd/m ² HLG)	Nominal Signal Level	
		%PQ	%HLG
Grey Card (18%)	26	38	38
Greyscale Chart Max (83%)	162	56	71
Greyscale Chart Max (90%)	179	57	73
Reference Level: HDR Reference White (100%) also diffuse white and Graphics White	203	58	75

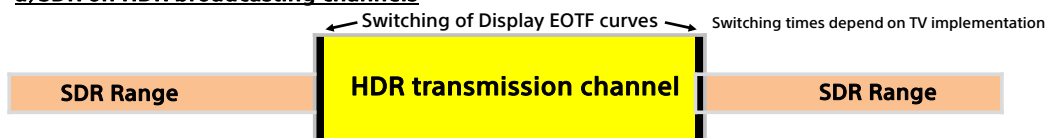
Approximate signal levels in PQ and HLG production

Reflectance Object	Nominal Luminance cd/m ² (PQ & 1 000 cd/m ² HLG)	Signal Level	
		%PQ	%HLG
Skin Tones (Fitzpatrick Scale)			
Type 1 - 2 Light skin tone	65 - 110	45 - 55	55 - 65
Type 3 - 4 Medium skin tone	40 - 85	40 - 50	45 - 60
Type 5 - 6 Dark skin tone	10 - 40	30 - 40	25 - 45
Grass	30 - 65	40 - 45	40 - 55
Ice Rink	155	55	70
White Objects	140-425	54-66	70-75

"Display Referred" : SDR and HDR transmission issues

Current Broadcasting of SDR and HDR programs

a) SDR on HDR broadcasting channels



b) HLG signals from SDR original content



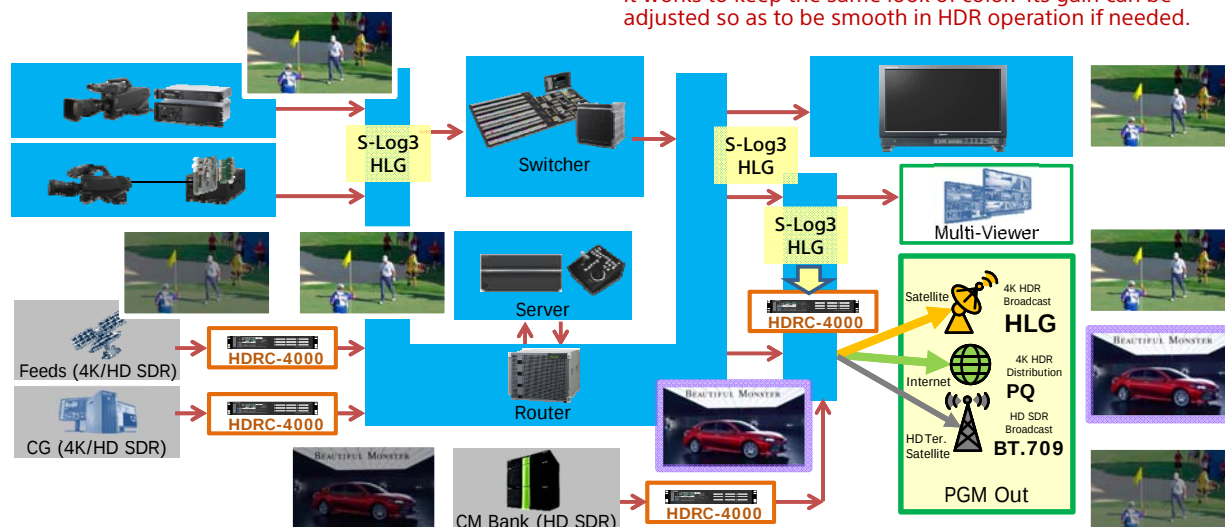
New UHD broadcasting services employ Playout Servers with a mixture of SDR and HDR programs or SDR commercials inserted on main HDR programs. Sometimes it is required to maintain the look of the SDR program due to content owner preference.

A solution implemented in the HDRC-4000 converter is to use a “Display Referred” processing technique to avoid switching the EOTF from HDR in the consumer TV set while maintaining the picture look established for the SDR signal

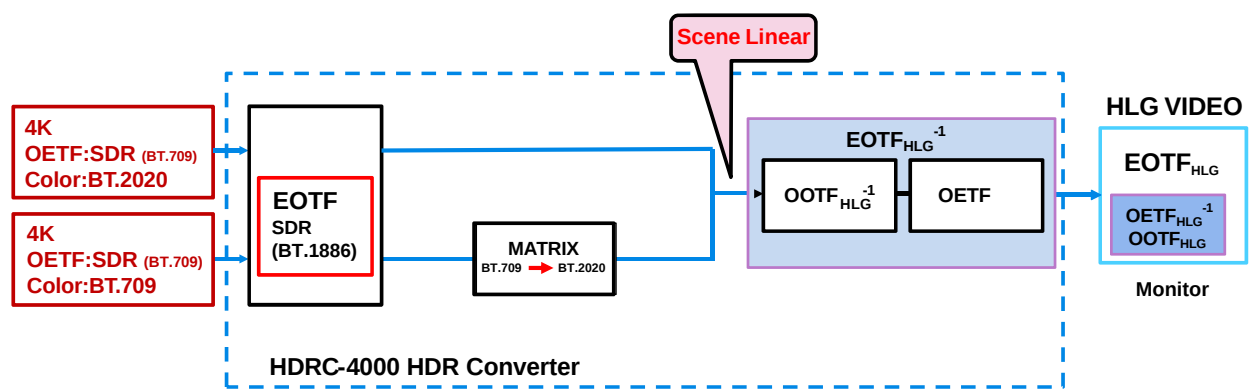
Display Referred (for SDR content over HDR Transmission)

To keep the same "look" as original SDR image.

It works to keep the same look of color. Its gain can be adjusted so as to be smooth in HDR operation if needed.



Display Referred



HDR Monitoring

HDR Monitoring Solution for 4K and HD Productions

EOTF support:

- SMPTE ST.208
- ITU-R BT.2100
- S-Log2, S-Log3, HLG (Live HDR)

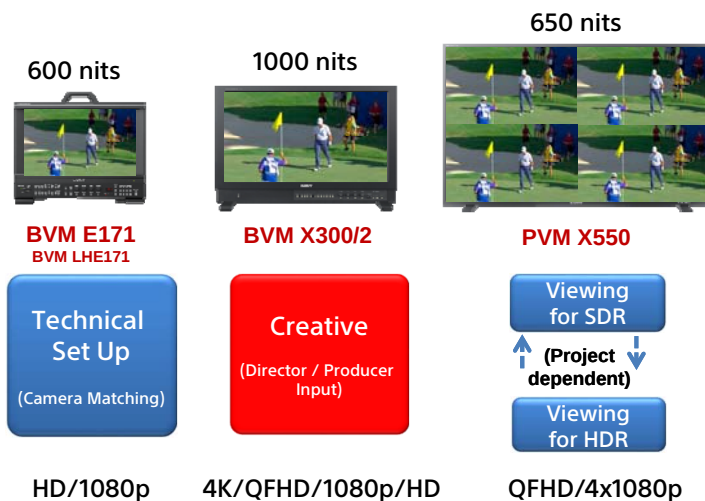
BVM E171 (HD)

& BVM X300/2 (4K/HD)

- Reference grade with 12 bit support
- WCG support of
 - ITU-R BT.2020
 - SMPTE RP.431-2 DCI P3

PVM X550 (4K/HD)

- Same processing as BVM X300/2
- OLED technology
- 4 Quadrant Display (1080P)



Tools for Live HDR Production

SR Live
for HDR



THANK YOU..... !!!!!!!

SONY