



MasterClass





Masterclass agenda

1. Where are we with UHD?

- State of the industry
- Operator Survey Results
- Interoperability today

Thierry
Fautier

2. Where UHD is heading?

- Smarter pixels
- High Frame Rate
- Examples from the field

3. Zoom on next generation audio



Operators / Members Live Deployment



Date	Operator	HDR	Audio	Status
May'16	 DIRECTV.	SDR	5.1	Commercial service
June'16	 NeuLion	SDR	5.1	Commercial service
June'16	 kpn	SDR	5.1	Friendly
Aug'16	 Comcast.	SDR / HDR10	5.1 / Atmos	Commercial service
Aug'16	 sky	SDR	5.1/ Atmos	Commercial service
Rio'16	.	SDR / HDR10	5.1 / Atmos	Commercial service
Oct'16	SKY PerfectTV!	HLG	5.1	Commercial service
April'17	 DIRECTV.	HLG	5.1	Trial/Demo
May'17		HLG	5.1	Commercial service

Ultra HD Forum Progress



Members

51

Guideline (Phase A)

V1.4 (incl best practices)

Interop

DTG/DTV Platform plug fest (June'17)

Operator Survey

Phase B planning

Communication

Master Class on UHD @ IBC'17

What is coming Next ?



Interop

Guideline

China

ATSC 3.0

Liaison

5 Demos on EBU booth

Phase B survey result

UBB Forum (Huawei Oct'17)

Meeting in Korea (Winter Olympic'18)

UHD Alliance on Broadcast
SMPTE (SDI HDR signaling/ST 2094)

Phase B



Topic	Details
NGA	Object based
New HDRs	Dolby, Technicolor, HDR10+, ST 2094, China ,...
HDR Dual Layer Technology	Backward compatibility
HFR	P100 & 120
HDR Conversion Tools	HDR10 <> HLG
HDR “Brightness” Control	Could become a regulated topic
Applications : OTT	Live & VoD
Applications : OTA	ATSC 3.0 / DVB-T2 / ISDB-T
Applications : MVPD	Broadcast / IP Unicast & Multicast



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Madeleine
Noland

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Introduction: Service Provider Survey



- A Service Provider Survey was conducted to help guide Phase B efforts and other UHDF activity
- Only service providers were requested to participate (Cable, IPTV, OTA broadcaster, DBS, OTT, etc.)
- Many thanks to ATSC, NAB, DTG, Forum Audiovisuelle Numérique, and other organizations for helping promote the survey
- 80+ respondents
- ***“Consider the next 2-5 years”*** was the context for the questions



Introduction: Ultra HD Forum Guidelines



- The Ultra HD Forum Guidelines explain the complex UHD landscape
- Phase A Guidelines describe processes providing linear UHD services by 2016
 - Phase A Guidelines v1.4 released at IBC 2017
- Phase B Guidelines cover new UHD technologies which were not commercially available in 2016, but have become available since then and have significant momentum within the industry
 - The Service Operator Survey was conducted in part to guide development of this document





Phase B Technology Inclusion Criteria

1. the technology must be proven to be functional in an end-to-end workflow that is within scope of the Guidelines document (or that portion of the workflow that pertains to the technology), either via early deployment or via interop testing to members' satisfaction
-AND-
1. at least 2 service providers (or 1 major provider) demonstrate interest in the technology; service providers do not need to be members of the UHDF, and their support may be demonstrated, for example, by written confirmation to the UHDF working group, or by verifiable products in production that support the technology, etc.





Phase B Technologies

The following technologies have met the Phase B inclusion criteria:

- Technicolor SL-HDR1
- Dolby Vision
- High Frame Rate (120/100 fps), for HD resolution content
- Next Gen Audio
 - AC-4
 - MPEG-H
- Scalable HEVC (SHVC)
- More technologies may be added as the work progresses



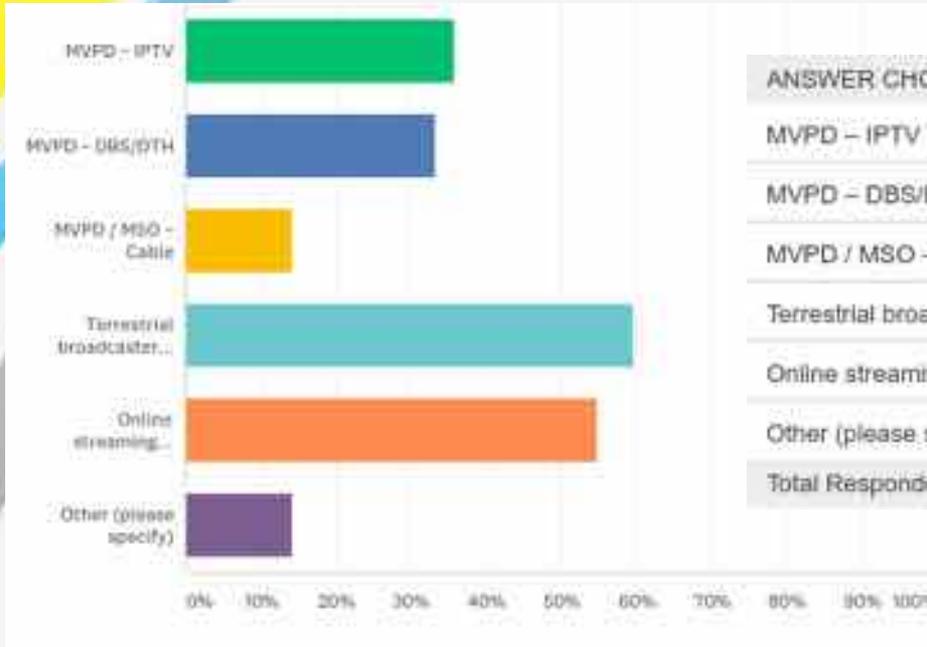


Survey Topics

- Survey topics included:
 - UHD in general, including spatial resolution, color space and dynamic range
 - HDR, including transfer function (PQ/HLG) and metadata
 - **Phase B technologies**
 - Video codecs
 - Information about the respondent's operation
- This presentation covers some of the results related to Phase B technologies



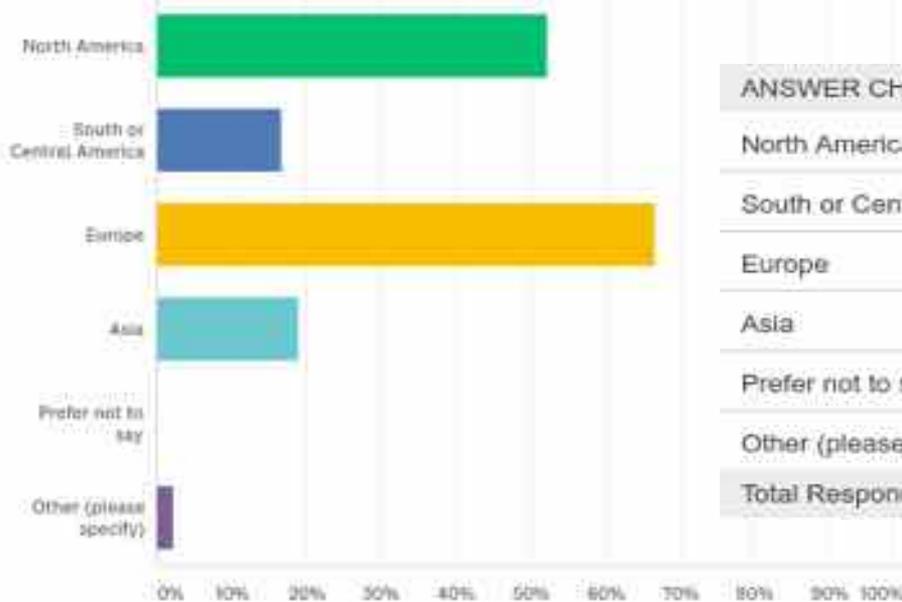
About the survey respondents: How do you categorize your operation?



ANSWER CHOICES	RESPONSES
MVPD - IPTV	35.71%
MVPD - DBS/DTH	33.33%
MVPD / MSO - Cable	14.29%
Terrestrial broadcaster (DTT/OTA)	59.52%
Online streaming service (OTT)	54.76%
Other (please specify)	14.29%
Total Respondents: 42	

About the survey respondents

In which region(s) do you operate?



ANSWER CHOICES	RESPONSES
North America	52.38%
South or Central America	16.67%
Europe	66.67%
Asia	19.05%
Prefer not to say	0.00%
Other (please specify)	2.38%
Total Respondents: 42	



Survey results for SL-HDR1 (1 of 2)

- 50% of respondents were familiar with SL-HDR1
 - Those not familiar skipped the SL-HDR1 questions
- 76% found the main customer benefit to be “Maintaining competent color across SDR & HDR presentations”
- 100% of cable operators (and others as well) considered a competent SDR picture on non-HDR devices to be a benefit of SL-HDR1
- Business benefits included distribution of HDR content as SDR as beneficial (71%)
- Business benefits also included production in their preferred HDR format (e.g., HLG, HDR10, SLog3) (81%)



Survey results for SL-HDR1 (2 of 2)



- 81% saw benefit in not requiring static or dynamic metadata carried in production
- Survey comment: “Automatic conversion of HDR to SDR for Live production may impact the quality of the SDR production”
 - Technicolor notes that evidence suggests the SDR is improved for live.
- Respondent comment: “Conversion box is required for HDR devices already sold”
 - Technicolor notes that some consumer displays support SL-HDR1 directly. Over 25 system-on-chip for displays, STBs, and dongles are currently available from 10 vendors. Regardless: There are no black screens.





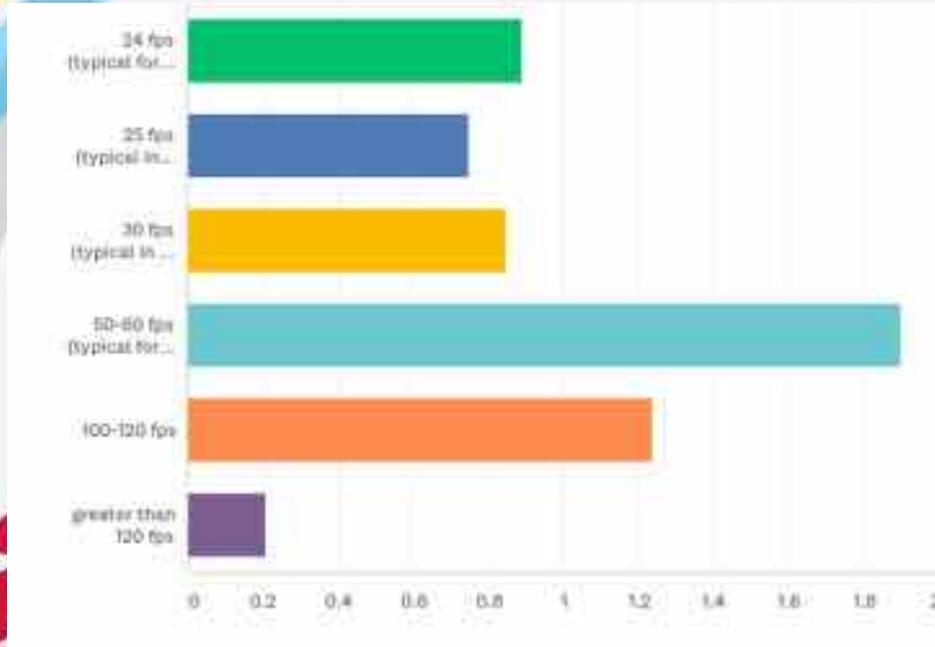
Survey results for Dolby Vision

- 85% of respondents were familiar with Dolby Vision
 - Those not familiar skipped the Dolby Vision questions
- “High-Quality Images” are Very Beneficial to more than half (51%) of the respondents, an additional 27% found high-Quality Images to be Somewhat Beneficial – less than 10% found this to be of No or Low benefit.
- Consistent/Predictable HDR reproduction found to be Very Beneficial to more than half the respondents (54%) with another 34% finding it Somewhat beneficial – only 5% found this feature of no or low benefit.
- Respondents found Dolby Vision more valuable for Pre-recorded content (71%) than for Live Content (44%).





Survey results for HFR: What frame rate(s) do you see as valuable?



87% said 50/60fps is “very valuable” and no one said it is “not very valuable”

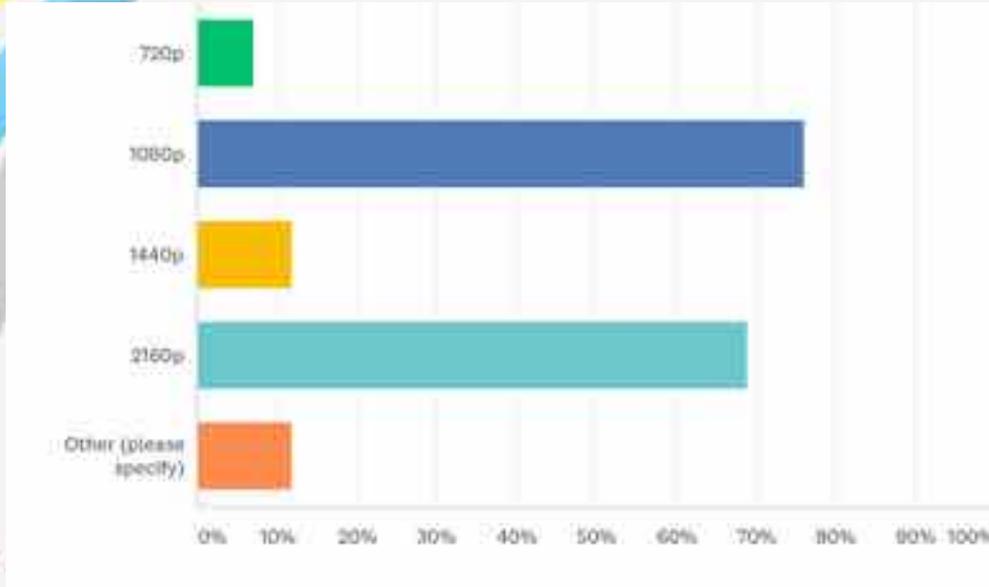
42% said 100/120fps is “very valuable” and 27% said “somewhat valuable”

People are not looking beyond 120fps in the next 2-5 years

Note: The horizontal axis indicates a weighted score for answers formatted as “very”, “somewhat”, and “not very”



Survey results for HFR: What spatial resolution(s) are valuable with 100/120fps?



1080p is the top spatial resolution choice for HFR

2160p is a close second

Very little interest in 720p or 1440p





Additional survey results for HFR

- Comments included:
 - “Infrastructure and production costs/challenges are a barrier”
 - “Concern that not enough content would benefit from HFR”
- Less than 15% have experimented with HFR
- Over 93% think backward compatibility is “somewhat” or “very important”
 - These numbers are higher than for HDR and NGA backward compatibility
 - Only 7% think backward compatibility is not important or aren’t sure
- The top-rated consumer benefit of HFR is for improved action scenes and sports
 - One respondent said maybe not Cricket, though! 



Survey results for Next Gen Audio

- The benefits of NGA were fairly evenly favored with enhanced dialog and immersive audio scoring slightly higher than other benefits
- Lots of uncertainty regarding NGA
 - 20-30% uncertain on channel-based height info, dynamic audio objects and HOA
 - 30% uncertain about which system(s) they would consider
 - 30% uncertain about how to address backward compatibility
- **Concerns included:**
 - Challenging to implement for service providers and producers
 - Challenging to implement for consumers
 - Demand is unproven; consumers haven't even adopted 5.1 on a mass level
- **Comment: “education is needed on NGA”**



Survey Results for SHVC

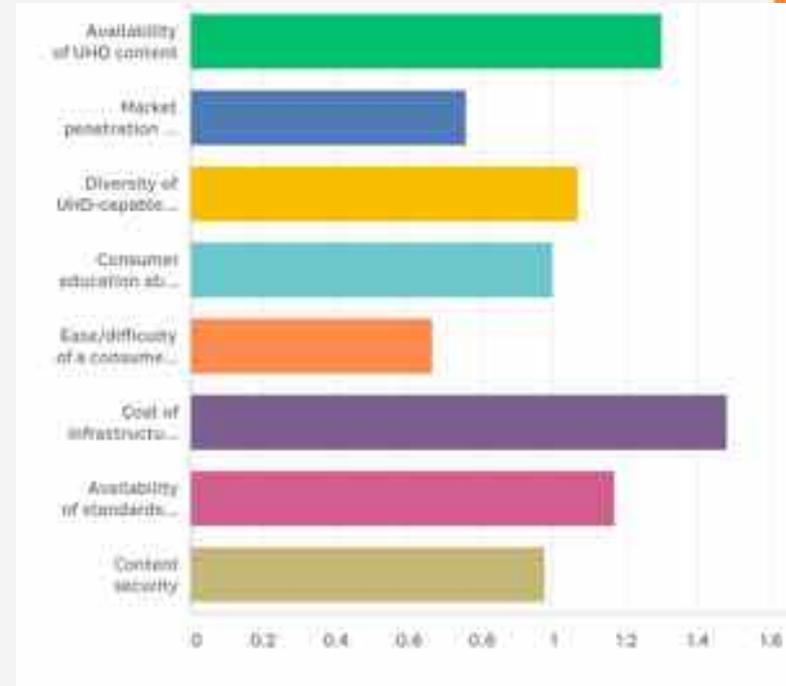
- 43% of respondents were familiar with SHVC
- Valued uses included:
 - Distributing a lower resolution base layer for mobile (71%)
 - Distributing both base and enhancement layers over the same channel (82%)
 - Distributing base and enhancement layers over distinct channels (59%)
 - 65% saw value in using the enhancement layer for premium services





What do you see as barriers to launching UHD services? (1 of 2)

1. Cost of infrastructure
2. Availability of UHD content
3. Availability of standards
4. Diversity of consumer devices
5. Consumer education
6. Content security
7. Market penetration of consumer devices
8. Ease/difficulty of consumer set-up



Note: The horizontal axis indicates a weighted score for answers formatted as “very”, “somewhat”, and “not very”



What do you see as barriers to launching UHD services? (2 of 2)

People also provided other entries for barriers:

- market demand in OTA
- cost of delivery in OTT
- availability of IP-based infrastructure
- lack of single HDR solution (x2)
- MVPD customers and advertisers not willing pay more for UHD
- quality of UHD content (sometimes not much better than HD)





Q: What standards, guidelines or recommended practices are Still needed for UHD services? (1 of 2)

- Guidelines for production
 - Guidelines on how to produce HDR
 - ***Need for “sub toolkits”, i.e., instruction on how to best produce based on content type (x3)***
 - Recommended Practices for simultaneous UHD/HDR and HD/SDR production (x2)
- Service preparation
 - Recommended practices for SDR<>HDR and 2020<>709 conversion





What standards, guidelines or recommended practices are Still needed for UHD services? (2 of 2)

- **Signaling and Transport**
 - Standards for signaling HDR (in IP and SDI) (x4)
 - An alternative for MPEG HEVC is needed by 2020
 - ATSC 3.0 completion (x4)
- **Decoding and Rendering**
 - HDR standards on all TV inputs (IP, HDMI, USB, etc.) (x4)
 - Robust and reliable control and switching of HDR modes in consumer TVs (x2)





Next Steps

- Publish survey results after fully analyzing data
- Repeat the survey regularly to see trends
- Work with Standards Development Organizations to fill gaps in standards
- Identify and document UHD “sub-toolkits” for different content and service types
- Conduct Inter-Ops to test “sub-toolkit” workflows
- Continue developing UHD end-to-end Guidelines to help operators make wise choices for their businesses





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Interoperability Today

What Ultra HD Forum
Plugfests are Telling US
About the Future of UHD



Formats & Capabilities



BT.2100 10 Bit **HDMI2.0** ST.2094-40 8 Bit
ST.2084 **HDMI2.0b** **HDR10** HDR10+

SDR **PQ** **HLG** **SL-HDR1**
ST.2094-10 **BT.2020** HDMI2.1

HDMI2.0a **BT.709** **Advanced HDR** **Dolby Vision**

ST.2086

ST.2094-30

DCI-P3

ST.2094-20

12 Bit

Metadata Support



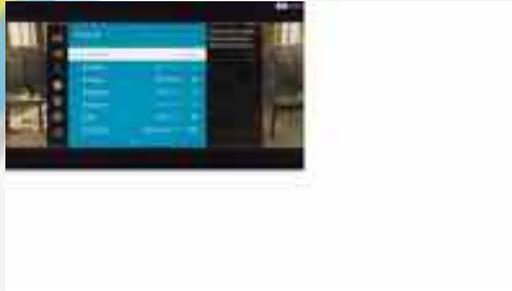
MaxFALL

MaxCLL

Mastering Colour Display Volume



UI Complexity & Vocabulary





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Pat Griffis
Stephan
Heimbecher



3. Zoom on next generation audio



HDR of Tomorrow – Better, Smarter Pixels

Patrick Griffis
Vice President, UHD Forum
VP Technology
Office of the CTO
Dolby Labs



Goals For This Presentation



- Understand the new language of “color volume” and a key challenge of the HDR age to map content from one color volume to another to preserve creative intent (whether episodic or live).
- Understand that new technology makes possible the analysis and delivery of content attributes on a scene by scene basis making pixels “smarter” to facilitate this process.
- Understand that SMPTE has completed a suite of standards ST-2094 which defines mechanisms for delivering the content information with frame level precision.
- Understand that services and products deploying these techniques are already in market for OTT, Blu-ray, and soon broadcast with more to come.



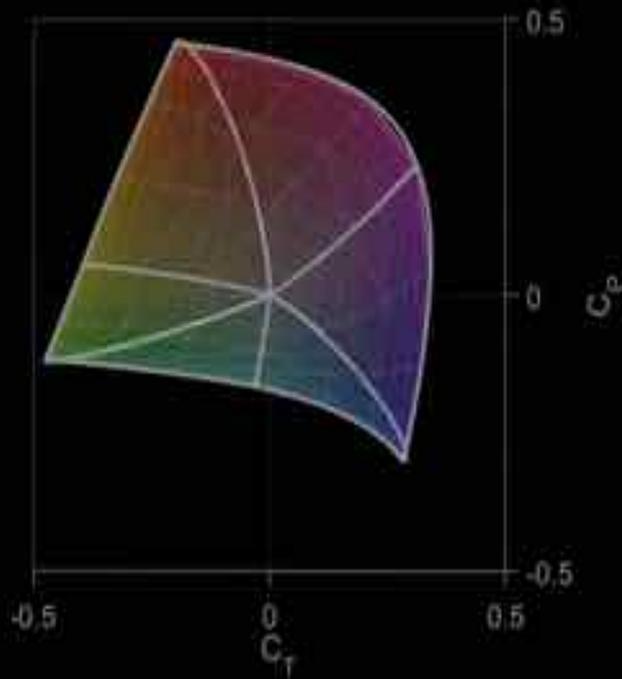
An HDR Display



Content courtesy of the EBU

Display Color Volume

The 3D palette of all colors that can be reproduced at all allowable intensities



Content courtesy of the EBU

Image Color Volume

The pixels that comprise the HDR image change location on a frame by frame basis



An HDR Image



HDR: Opening the Lid to “Pandora’s Pixel” Box

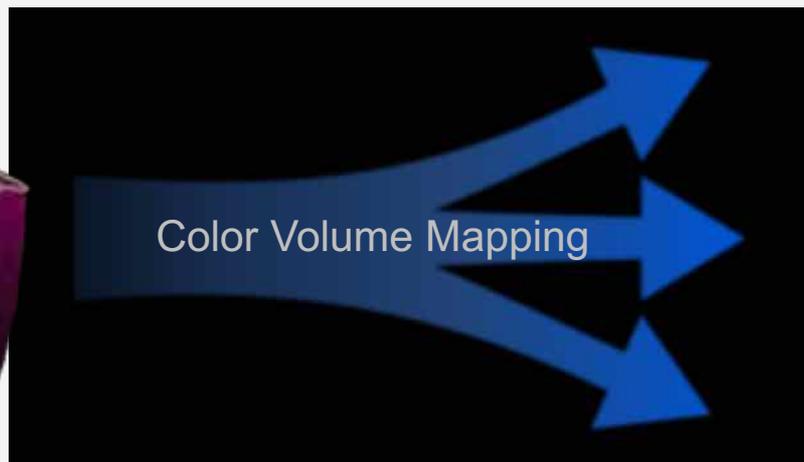


Content courtesy of the EBU

Putting “Pandora’s Pixels” Back in the Box!



- Each target display has a different color volume
- Use Color Volume Mapping to correctly place pixels into the target display color volume preserving relationships
 - Both Tone Mapping (intensity) and Gamut Mapping (color)



Typical UHDA HDR Display e.g. OLED/LCD



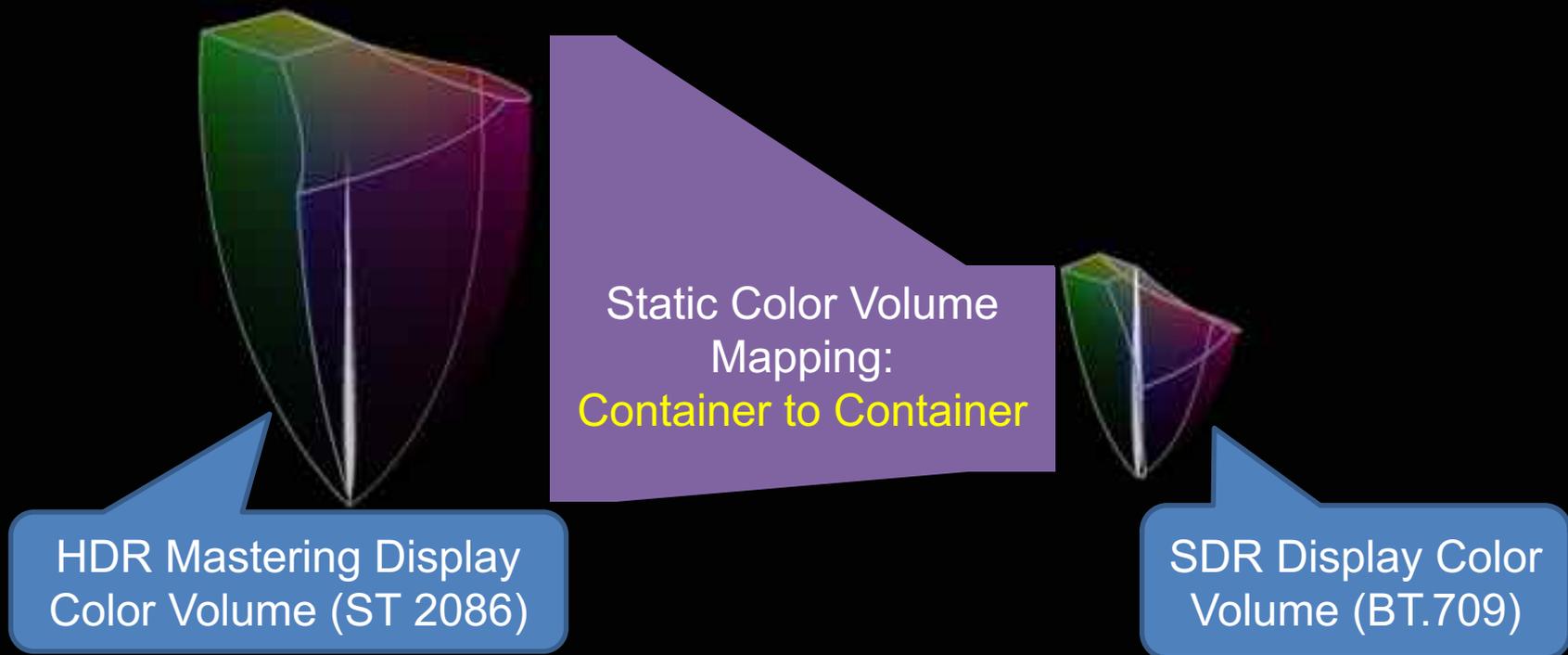
Legacy SDR 709 Display



Future HDR Display

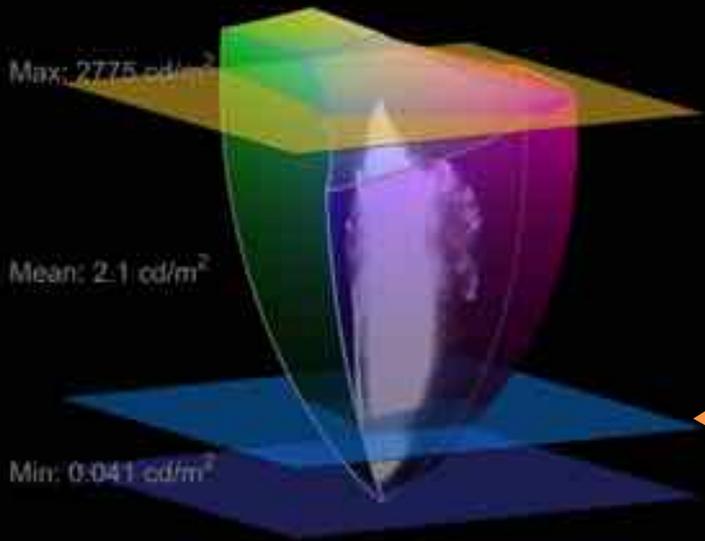


Putting the Pixels in the Box: Static Container Mapping of HDR to SDR



A Better Way...

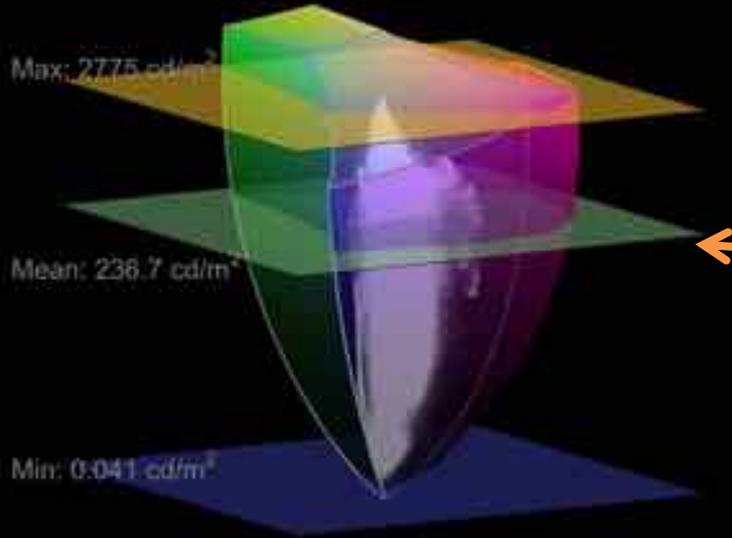
Map the **Content** based on real time image content analysis



Region of the image to prioritize

A Better Way

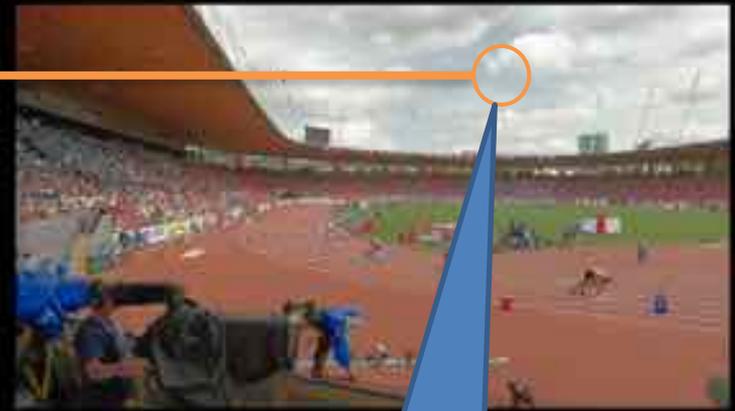
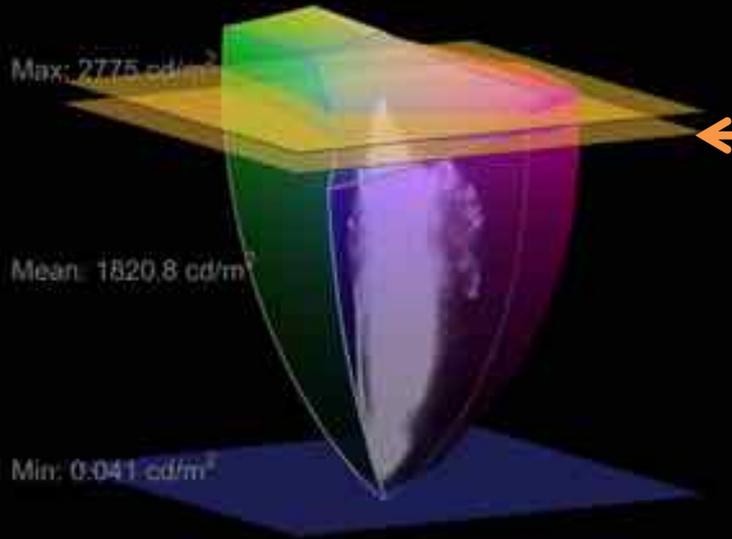
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Region of the image to prioritize

A Better Way

Map the **Content** based on real time image content analysis



Region of the image to prioritize

Delivering Real-time Content Characteristics: ST 2094

“Dynamic Metadata for Color Volume Transform”



- SMPTE ST 2094 is a suite of dynamic metadata standards for color volume transforms
- ST 2094-10:2016 Standard provides:
 - A parametrically-defined color volume mapping computed from the input content i.e. it is a “descriptive” system rather than a “prescriptive” system
 - The most important elements for **live** production are:
 - deep shadow => Min
 - mid-tone (facial and interior) => Mid
 - highlight regions => Max
 - Computed on a frame by frame basis, but adaptively smoothed to provide temporal consistency during rapid image brightness changes
- ST 2094-10 is now in Candidate Standard ballot for ATSC 3.0

“Smarter Pixels” = Better, More Consistent Pictures



- Tracking content characteristics in real time makes pixels smarter to improve reproduction quality and consistency across a growing variety of consumer displays from media room to mobile
- Dynamic Metadata provides the mechanism to do this
 - Optimizes content mapping of HDR to SDR (or intermediate brightness levels)
 - Preserves more contrast in dark and bright images
 - Minimizes mapping when the image is already in the target range, thus maintaining the original image contrast
- ST 2094-10 dynamic metadata standard enables mapping from **any** arbitrary production color volume to **any** arbitrary consumer device color volume providing future-proof scalability
- Dolby’s implementation of ST 2094-10 is widely deployed today via OTT in episodic, starting for Blu-ray and Mobile, and soon for live content

Over 100 “Smarter Pixels” Titles in the Market Today



“Smarter Pixels”- Work in LIVE!



- For HDR Broadcast plant
 - A unified PQ HDR workflow is interoperable with legacy SDR and compatible with other approaches and provides the highest quality open standard method to capture and process HDR. PQ is already the preferred choice of Hollywood and OTT.
 - Supports legacy 10 bit baseband broadcast infrastructure– 3G SDI
 - **No** metadata traverses the plant infrastructure– derived at the final encoding stage just before emission/transmission
 - Transmission with standard HEVC main10 codec – single layer PQ encoding with SMPTE ST-2094-10 metadata carried in an SEI message

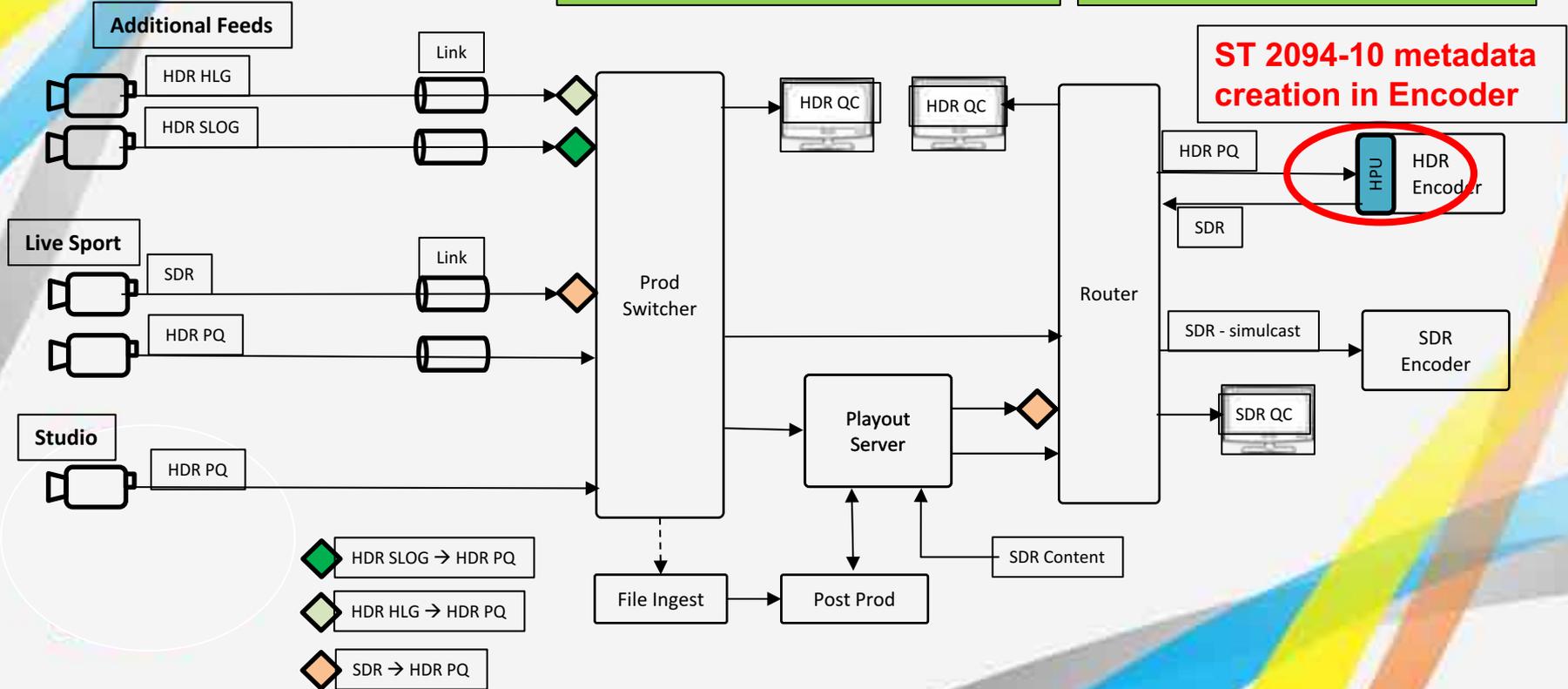




“Smarter Pixels” HDR Broadcast Plant Overview

LIVE BT.2100 PQ WORKFLOW

LIVE TRANSMISSION w/2094-10



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Thank You!





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Madeleine
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Introduction: Ultra HD Forum Guidelines

- The Ultra HD Forum produces Guidelines to help the industry navigate the complex UHD landscape
- Phase B Guidelines will focus on new UHD technologies which were not commercially available in 2016, but have become available since then, or have significant momentum within the industry
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HFR in DVB and ATSC

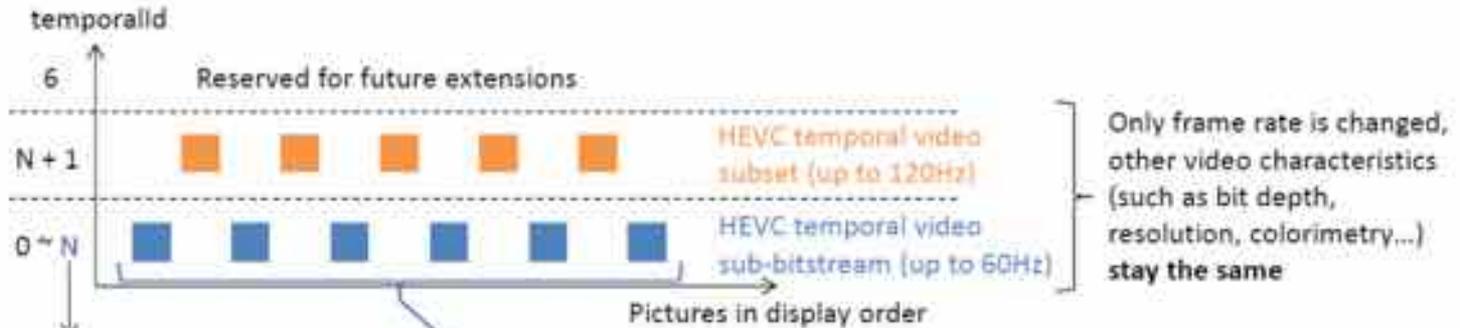
- Both DVB UHD-1 Phase 2 (ETSI TS 101 154 v. 2.3.1) and ATSC 3.0 (A/341) include framerates up to 120 fps
- Both include optional **temporal sub-layering** for backward compatibility
- ATSC A/341 includes optional **temporal filtering** for enhancing the standard framerate picture when temporal sub-layering is used

Temporal Sub-layering



DVB-UHD phase 2: HFR backwards compatible solution

- Use of HEVC temporal sub-layers with signalling based on temporalId



Constrained to one value N within a service so that `temporal_id_max` of the sub-bitstream does not change in case of switching to lower frame rate (also true for single PID bitstreams if temporal sub-layers are used)

The sub-bitstream:

- Contains all the Random Access Points
- Has constant rate of Decoding Time Stamps that is equal to or lower than $1/60$ s
- Conforms to the limits associated with Level 5.1





Temporal Sub-layering

- In the case that an HFR video stream is available, an SFR stream may be extracted by dropping every other picture
- HEVC temporal sub-layering identifies every other picture which enables division of the stream prior to decompression
 - The SFR frames are Temporal ID = 0
 - The additional frames needed for HFR are Temporal ID = 1
- SFR devices render the frames with ID = 0
- HFR devices render all frames, i.e., ID = 0 and ID = 1
- In DVB, dual PIDs are used to carry the two sub-layers
- ATSC 3.0, one video stream includes the two temporal video sub-streams (for ROUTE/DASH protocol implementations)



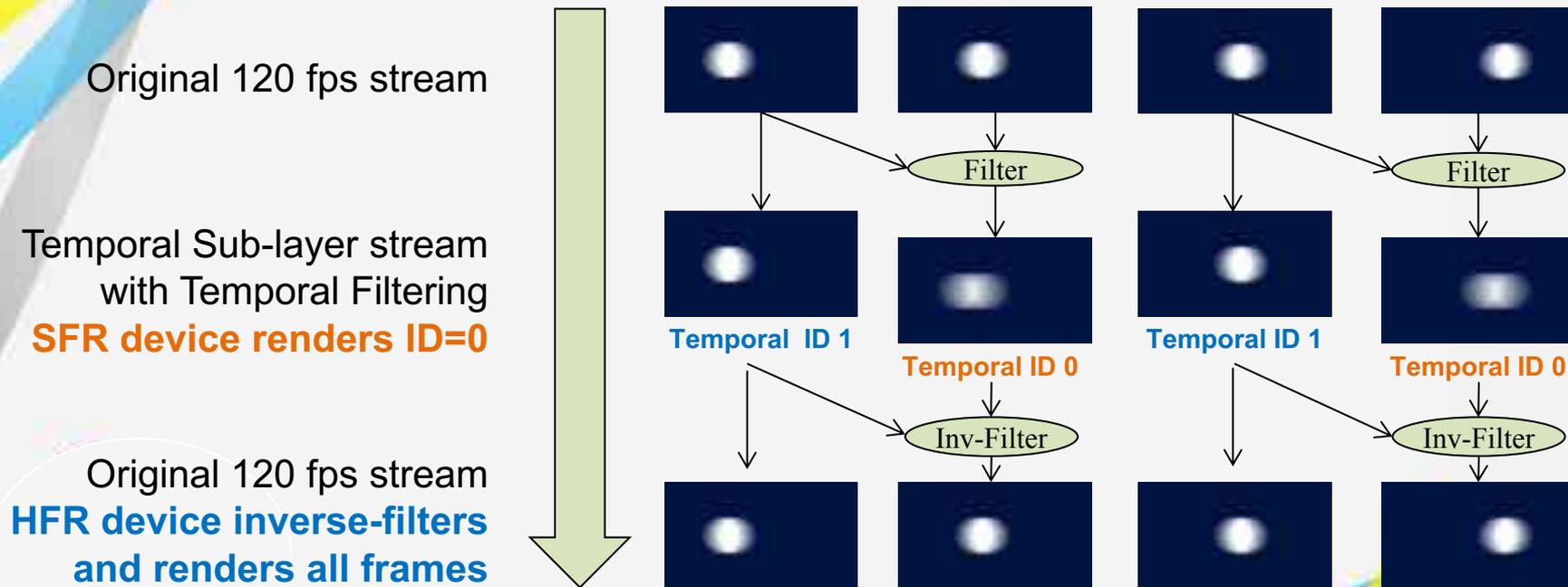
Temporal Filtering in ATSC 3.0

- According to A/341, achieving backward compatibility by rendering every other frame may cause unwanted strobing, depending on the camera angle used to capture the HFR image
- Temporal filtering is designed to improve the image quality on SFR devices
 - The SFR device plays the filtered SFR frames (filtered frames are optimized for SFR)
 - The HFR device recovers the original, pre-filtered SFR frames and renders all frames (pre-filtered frames are optimized for HFR)





Temporal Filtering





HFR on display at IBC

- SES/Astra booth (Hall 1, B51)
 - 2160p100, SDR, BT.709
- Ateame booth (Hall 1, D71)
 - 1080p100, HDR, BT.2020
- DVB booth (Hall 1, D81)
 - 1080p100, HDR, BT.2020
- EBU booth
 - Ultra HD Forum demo (Hall, 10 F20)
 - 1080p100, HDR, BT.2020

4EVER-2 First Live HFR end to end demo May 2017



Real scene,
Aren'Ice (Paris)



**6 HFR 1080p100 Cameras,
mikes**

Production



**Mixing and encoding
HFR and NGA**

Transmission

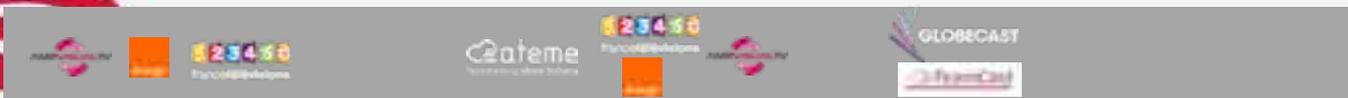


**Satellite
broadcasting**

Reception



**Consumer
electronic
display**



Ultra HD Forum Phase B Guidelines



- The Ultra HD Forum's goal is to promote adoption of UHD industry-wide
- The Guidelines are intended to “demystify” UHD technologies so that operators can understand the possibilities and make wise choices
- Phase A Guidelines are available on the UHDF website; v1.4 was just released
- Phase B Guidelines will build on that work



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Simon
Gauntlett

3. Zoom on next generation audio





Ultra HD Forum - Masterclass

Stories from the bleeding edge:

World's First UHD + HDR +
NGA live broadcast

Simon Gauntlett

Director of Imaging Standards and Technology,
Dolby Laboratories



Summer of HDR Trials



- BT Sport launched Premier League Football in UHD with NGA on 31st Jan 2017
- Summer 2017 included several trials of HDR
- Culminated in UEFA Champions League Final
 - Over 25 HDR cameras
 - Slog3 live production
 - PQ10 contribution feed with Dolby Atmos
 - Live screening in the Dolby Soho Cinema
 - HDR presentation with live insertion of SDR adverts converted to PQ
 - Atmos to 2.0 transitions at advert break

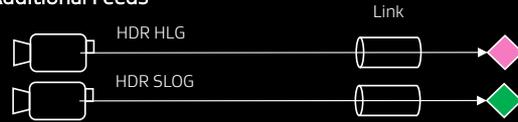


Generic HDR Broadcast Plant Overview

LIVE BT.2100 PQ WORKFLOW

LIVE TRANSMISSION w/2094-10

Additional Feeds



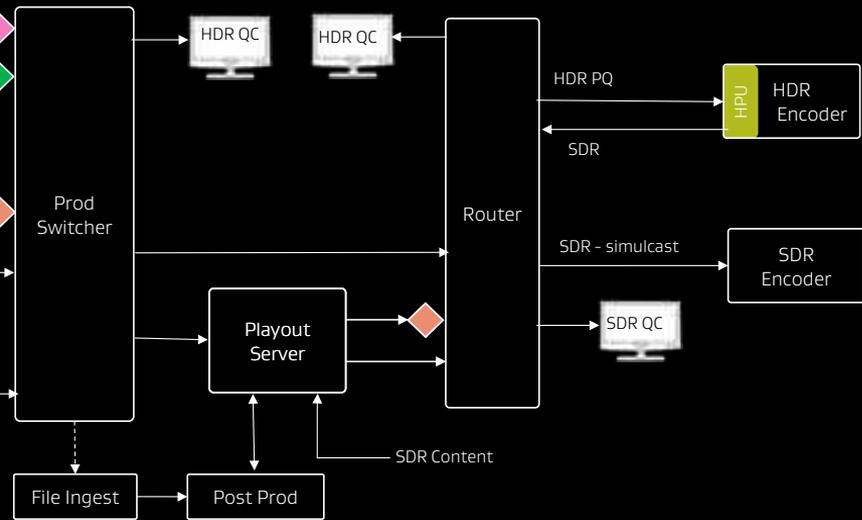
Live Sport



Studio



- ◆ HDR SLOG → HDR PQ
- ◆ HDR HLG → HDR PQ
- ◆ SDR → HDR PQ

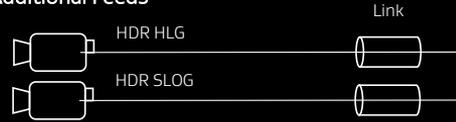


Generic HDR Broadcast Plant Overview

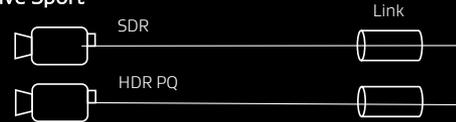
LIVE BT.2100 PQ WORKFLOW

LIVE TRANSMISSION w/2094-10

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Live Sport



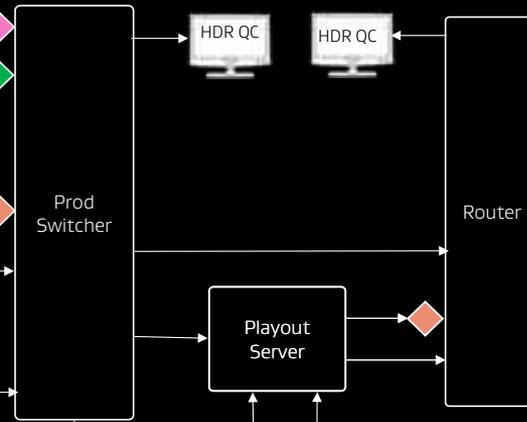
Studio



◆ HDR SLOG → HDR PQ

◆ HDR HLG → HDR PQ

◆ SDR → HDR PQ



HDR QC

HDR QC

ST 2094-10 metadata creation in Encoder



SDR QC



Summer of HDR Trials

- Waveform shows a wipe between Slog3 HDR camera and SDR camera converted to Slog3
- Then the whole Slog3 output converted to PQ
- Clearly see the pitch is aligned in both waveforms

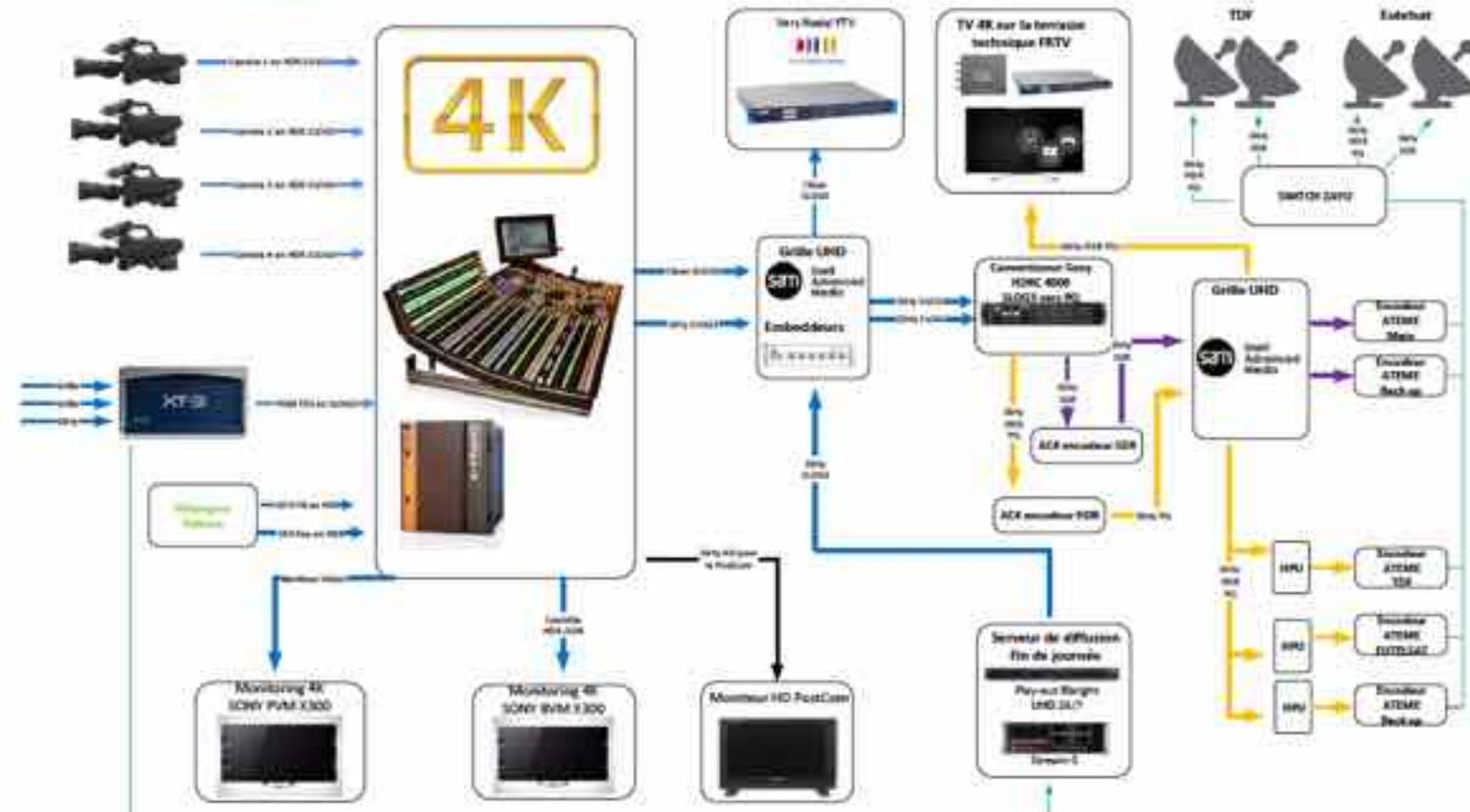


French Open 2017

- 4 Sony HDC 4300 cameras
- Slog3 live converted to PQ and SDR
- GrassValley Mixer
- SAM Kahuna conversion of HD SDR graphics to PQ
- Monitoring on Sony BVMX300
- Cameras racked in SDR with gain applied to HDR

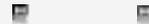


French Open 2017



French Open 2017

- HDR encoded by Ateame Titan Live with HPU
- Immersive audio mix using Dolby Atmos
- World first broadcast of Dolby Vision + AC-4
- Fransat (Eutelsat)
 - SDR 17.5 Mbps, E-AC-3 448 kbps
 - HDR 30 Mbps, E-AC-3 448 kbps, AC-4 256 kbps
- TDF (DVB-T2)
 - SDR 17.5 Mbps, E-AC-3 448 kbps
 - HDR 22.5 Mbps, E-AC-3 448 kbps, AC-4 246 kbps



 ateme



RTVE – Solemn Changing of the Royal Guard

rtve

- 4 Grassvalley cameras - 4000 Nits PQ
- Ateame Titan encoder – HEVC, E-AC-3 and HPU for dynamic metadata
- Contribution feed via Hispasat from Madrid to Barcelona and Seville
- DVB-T2 broadcast
 - 2160p50, 25Mbps HEVC with Dolby Vision
 - 128 kbps E-AC3
 - 48 kbps AC4
- 2 LG OLEDs and 2 Loewe OLED
 - HDR10 over RF inputs
 - Dolby Vision via HDMI from HiSilicon STB





Conclusions

- Summer 2017 saw shift from isolated camera trials to full multi-camera live productions in HDR
- Still learning how to get the best experience for both SDR and HDR viewers
- Proven PQ native and Slog3 workflows
- Proven realtime generation of dynamic metadata at point of transmission





Masterclass agenda

1. Where are we with UHD?

- State of the industry
- Operator Survey Results
- Interoperability today

2. Where UHD is heading?

- Smarter pixels
- High Frame Rate
- Examples from the field

3. Zoom on next generation audio



NGA session



- Chair: Skipp Pizzi (NAB)
- UX expert: Ludovic Noblet (B-COM)
- Panelist: Rob France (Dolby)
- Panelist: Stefan Melzer (Fraunhofer)
- Fadi Malak (DTS)



Experience



- We have entered a « beyond digital » era
- All about delivering experiences
- Audio: intelligibility, immersion, personalization, accessibility ... and beyond
- Services: TV, multi-screen ... and beyond



One key word



Engagement



Engagement



- Katz, Blumler, and Gurevitch (1974)
 - Uses and Gratification
 - Development stages back in the 1940`s...
 - What people do with media, NOT what media do with people
 - Audience centered approach, assumes people have needs that can be satisfied by media (gratification)
 - Information, identity, social interaction, escapism
- Pine & Gilmore (1998)
 - Experience Economy and the 4 realms of an experience
 - Immersion/absorption, passive/active participation
 - Work significantly expanded in 2001, 2009, 2015 & 2016



Back to NGA



- NGA not just about use cases
 - Storytelling/narration, intelligibility, immersion, personalization, accessibility
 - Think about how NGA can increase engagement
 - Leverage investment into contents
- A fundamental technology asset for the development of new media
 - Multi-screen and beyond (VR/deep media, AR/ambient media)
 - Avoid bottom-levelling
 - Prepare investment into the future

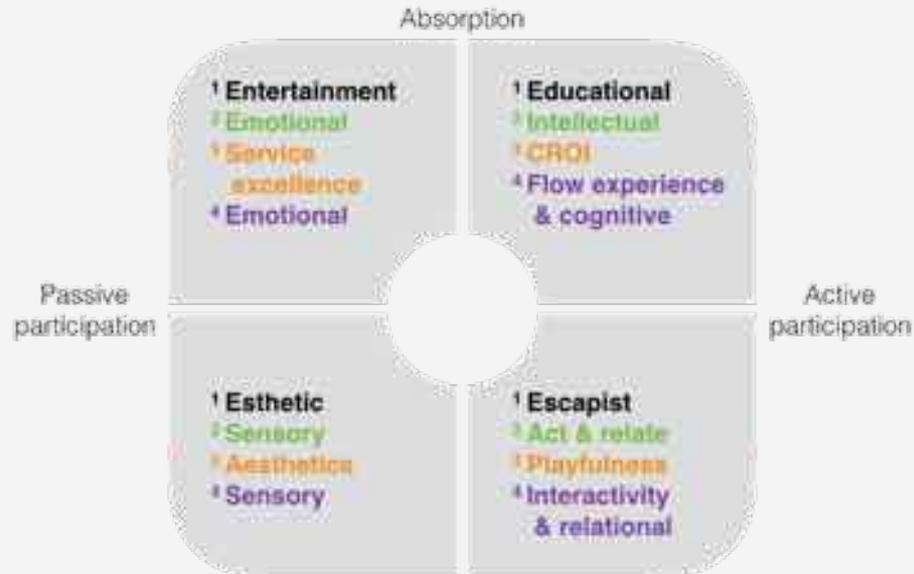




The 4 realms of an experience

The Four Realms of an Experience

Adapted from ¹Pine and Gilmore (1999); expanded with ²Solus, Schmitt, and Zarenbovic (2003), ³McEwick, Blahut, and Rogan (2003), and ⁴Vasquez and Cheng (2015) | Combined by Sebastiano Meru (2016)



*CROI: Consumer Return On Investment



NGA Panel



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