Mediakind

New Standards That Will Make a Difference: HDR & All-IP

Matthew Goldman SVP Technology MediaKind (formerly Ericsson Media Solutions)

HDR is Not About Brighter Display!





- SDR: Video generally $\leq 1.25x$; Cinema generally $\leq 2.7x$
- HDR: May be up to 100x

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Source: Report ITU-R BT.2390

"HDR" is Really 3 Advanced Image Technologies





High Dynamic Range





What is being called "HDR" is really the combination of HDR, WCG and higher sample precision technologies

Whether



Color Volume





CIE 1931 XY+ HDR Z

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Color Volume Mapping



- "HDR" displays have different color volumes
- Use color volume mapping to map into the target display color volume
 - Both tone mapping (intensity) and gamut mapping (color)
 - 3D color volume mapping



HDR Systems: "Static"



- PQ10 = SMPTE ST 2084 PQ HDR transfer function (also in Rec. ITU-R BT.2100)
 + UHD WCG (in BT.2020 → BT.2100) + 10-bit sample depth
- **HDR10** = PQ10 + reference display metadata (static)
 - Metadata = SMPTE ST 2086 HDR *static* metadata* + MaxCLL + MaxFALL
 - Specified by Blu-ray® Disc Association, DECE, CTA, UHD Alliance for preproduced content
 - ***ST 2086:2014** Mastering Display Color Volume Metadata Supporting High Luminance and Wide Color Gamut Images
 - Specifies mastering display primaries, white point, and min/max luminance
 - Used in HEVC: Mastering Display Color Volume & Content Light Level SEI messages
- **HLG10** = HLG HDR transfer function (in BT.2100) + UHD WCG + 10-bit sample depth
 - No metadata

HDR Systems: "Dynamic"



- Dynamic metadata systems = PQ10 + frame-by-frame "Display Adaptation" metadata
- SMPTE ST 2094-x suite Content-Dependent Metadata for Color Volume Transformation of High Luminance and Wide Color Gamut Images
 - Specifies dynamic metadata used in the color volume transformation of source content mastered with HDR and/or WCG imagery, when such content is rendered for presentation on a display having a smaller color volume
 - 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

HDR Systems: "Dynamic" (2)



Dolby Vision

- Defined in SMPTE ST 2094-10
- Descriptive metadata

• Samsung HDR10+

- Defined in SMPTE ST 2094-40
- Descriptive metadata

Philips/Technicolor SL-HDR1

- Defined in **ETSI TS 103 433-1** v1.2.1 (2017-08) *High-Performance Single Layer Directly Standard Dynamic Range (SDR) Compatible High Dynamic Range (HDR) System for use in Consumer Electronics devices (SL-HDR1)*
- **Prescriptive** metadata: carries the dynamic color volume transform metadata created during the down-conversion to SDR process
 - Required to recover the original HDR color volume

HDR Signaling & Metadata Carriage

Contribution





- Signaling carried in SMPTE ST 352 Payload ID
 - HD-ŠDI (ST 372), 3G-SDI (ST 425-1)
 - 6G-SDI (ST 2081), 12G-SDI (ST 2082)
- Metadata carried per
 - **SMPTE ST 2108-1** HDR/WCG Metadata Packing and Signaling in the Vertical Ancillary Data Space
 - SMPTE ST 2108-2 Vertical Ancillary Data Mapping of KLV Formatted HDR/WCG Metadata

Pro Media over IP (SMPTE ST 2110)

• ST 2108 metadata carried in **SMPTE ST 2110-40** *Transport of SMPTE ST 291-1 Ancillary data*

CTA/HDMI Forum (CTA 861-G)

• Minimum HDMI 2.0b

Emission

Compressed

- For 4K: HEVC Main10 Profile
- Signaling carried as VUI messages
- HLG has a compatibility mode where the HLG TF is signaled in an SEI
- Metadata as AVC | HEVC SEI messages
 - Unfortunately, the mapping is not identical
 - Each HDR scheme uses a different defining document, different provider code, different internal structure
 - No coordination but there does not appear to be any conflicts

Distribution

Mixing SDR into HDR Flows: SDR-to-HDR Upconversion

- Early HDR Live TV will have a limited amount of HDR content
 - SDR content likely to be mixed with HDR content during an HDR broadcast
- SDR needs to be converted for correct visualization on HDR displays
- While one cannot "create" HDR from SDR, as the SDR content has no HDR information, one can "balance" SDR hue saturation and luma values, so that it looks correct on a HDR TV, running in HDR mode
 - Real-Time Intelligent Inverse Tone Mapping







Tone Mapping Matters





HDR

SDR

SDR

HDR

Tone Mapping Matters





So What About 1080p HDR?



- If bandwidth constraints prevent a broadcaster from offering all of the new technologies, then focus on the "best bang for the bit"
 - 1080p50/60 HDR
- Take advantage of all modern displays' ability to up-convert 1080p to 4K (2160p)
 - Of course, display must support HDR to render HDR

Why IP for Contribution, Live Production, & Playout?



- 1. To enhance the *flexibility* & *agility* of the video plant
- 2. Compatible with network interfaces on *commodity* Ethernet switches and *commodity* servers
- 3. Flexible association of streams into desired groups of media
- Network-based registration and discovery of devices, streams, and media capabilities
- 5. Denser than SDI and inherently bi-directional
- 6. Agnostic to specific video format (resolution, bit depth, frame rate, etc.)

The "on-ramp" to the **software-oriented**, **virtualized** video production plant

Simplifies and Reduces Cabling





Equivalent amount of 3G-SDI cabling required

Example: 4K Ultra-HD OB Truck

IP/Ethernet

1 Rack

SMPTE ST 2110-x Suite of Standards MediaKind

- ST 2110-0 Roadmap for the document suite
- ST 2110-10 "System Timing & Definitions"
- ST 2110-20 "Uncompressed Active Video"
 Based on RFC 4175
- ST 2110-30 "PCM Digital Audio"
 - AFS67
- ST 2110-40 "SMPTE ST 291-1 Ancillary Data"
 Captions, subtitles, time codes, active format description, dynamic range, etc.
 Co-developed with IETF as new RFC 8331 RTP Payload for SMPTE ST 291-1
- ST 2110-21 "Traffic Shaping & Delivery Timing for Video"
- ST 2110-31 "AES3 Transparent Transport"
 Includes compressed audio
- ST 2110-22 "Constant Bit-Rate Compressed Video"
- RP 2110-23 "Single Video Essence Transport over Multiple ST 2110-20 Streams"
- ST 2110-41 "Fast Metadata"
- ST 2110-42 "Formatting of ST 2110 Sender SDP Object for Transport using ST 2110-41 Fast Metadata"



Approved & Published!

Related to SMPTE ST 2110



- SMPTE ST 2022-8 "Professional Media over Managed IP Networks: Timing of ST 2022-6 streams in ST 2110-10 Systems"
 - To be sent to Draft Publication ballot
- SMPTE ST 2022-7 Seamless Protection Switching revision
 - To add "ultra-low-skew" class and genericize to "All-IP" (includes ST 2110 RTP payloads)
 - To be sent to ST audit

Leverage IP Standards vs. Reinventing the Protocol Stack





Comparison of Real-Time Media over MediaKind IP-based Transport Protocols

IP layer



- SMPTE ST 2022-6
 - "SDI over IP"
 - RTP encapsulation
 - Easy conversion to/from SDI
 - Good for mixed SDI/IP system and interfacility where timing can't be tightly managed



- SMPTE ST 2110-x
 - Essence-based encapsulation
 - RTP encapsulation
 - PTP for timing
 - Good for IP-native systems, intra-facility

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Transformation Requires More Than MediaKind Just Media over IP Transport

- IT transformation promises flexibility; IP transport protocols alone do not deliver flexibility
- Static configuration of IP flows is cumbersome as it is, but ...
- Dynamic configuration of IP flows is what is desired
- IP-based architecture introduces problems such as lack of determinism and security concerns, which need to be addressed
- We need "smarter" networks & media processing
 - Software Defined Networking (SDN) abstracts the setup of low-level network functions
 - Do the same for media processing
 - Separates control plane (defining connections) from data plane (traffic carriage)
 - Standard interfaces can be used to interact with the control plane

AMWA NMOS





- Solves major shortcomings with today's SDI-based systems
 - **Discovery & Registration**: Find out about other endpoints on network & what flows are available, list on a shared registry, provide uniform way to query the registry
 - **Connection management**: Form a connection with another endpoint, identify flows and associate them with a timestamp
- Developed & tested through *Network Media Incubator* events



- Provides "Universal Plug 'n Play" for media
 - No manual entry of IP addresses and port numbers!
- Implementation Specifications
 - IS-04 NMOS Discovery and Registration
 - IS-05 Connection Management
 - IS-06 Network Control

Follows JT-NM Architecture Model

So ... Is Pro Media for IP Real?



Live use cases & interop of real-time professional media over IP IBC16, NAB17, IBC17, SMPTE ATC 17, NAB18, SET Expo 18, IBC18



Photos of the NAB18 IP Showcase



@ IBC 2018: Over 50 vendors!

MediaXind everyone. everywhere.