NABA HDR Recommendation Overview

August 2, 2021
There are two HDR systems defined in Recommendation ITU-R BT.2100–2 “Image parameter values for high dynamic range television for use in production and international programme exchange”

- Hybrid Log Gamma (HLG)
- Perceptual Quantization (PQ)

Supporting information on HDR can be found in Report ITU-R BT.2390–8 “High dynamic range television for production and international programme exchange”

The PQ–based HDR transfer function (SMPTE ST 2084) with optional static metadata (SMPTE ST 2086) with 10–bit coding is commonly referred to as HDR10

Delivery to consumers with HDR10 may optionally include additional static [SMPTE ST 2086] or dynamic [SMPTE ST 2094–10\(^1\) or ST 2094–40\(^2\)] metadata

The SL–HDR1 standard can use either PQ or HLG as its underlying HDR transfer function

Introduction

• NABA convened an HDR Study Group of Broadcasters to
  • Survey and discuss the current and likely future state of the multi–industry HDR landscape from various perspectives
    • Devices and Consumer use
    • OTT services
    • MVPDs and Retransmission
    • Content Production
    • HDR system conversions (technical performance)
    • Broadcaster “what if” scenarios and resulting consequences
      • Consider broadcast emission options and evaluate their potential consequences

• Broadcasting exists within a highly complex, multi–industry ecosystem…
ATSC 3.0 is Broadcasters’ path to HDR, but even a rapid rollout is well behind other sectors.

- Consumer Devices – broad support of HDR10
- Cable/MVPDs and OTT – deploying HDR10
- Movies and Scripted TV – typically HDR10
- Sports and Live Productions – typically HLG

Multiple HDR systems will co-exist and conversions will be performed:
- Any conversion adds complexity and is imperfect
- “Round-trip” conversions should be avoided
- “Round-trip” + additional conversions may reduce quality and introduce color shifts

When content goes through conversions, the end result is likely to be the worst aspects of each system – conversion never makes it better.

Broadcasters are faced with four fundamental questions:
1. “Which types of content will get converted?”
2. “Where is conversion performed?”
3. “By whom?”
4. “Will my own content be in different HDR systems on OTA and OTT?”
Video streaming (OTT and MVPD services) is growing fast and is clearly the future.

Streaming content is consumed across a broad set of devices
  - phones, PCs, tablets, game consoles, streaming STBs...

Nielsen Total Audience Report Aug 2020
HDR Consumer Device Landscape

- **Smart TVs**
  - Virtually all support both HDR10 and HLG

- **OTT Boxes & Gaming**
  - Virtually all support HDR10
  - Some also support HLG

- **Phones and tablets**
  - Virtually all support HDR10
  - A few also support HLG

- **PCs**
  - Virtually all support HDR10
  - A few also support HLG

- **Overall device landscape**
  - Virtually all devices support HDR10
  - HLG content will require conversion to HDR10 or SDR to reach devices that are not capable of HLG
Content Creation, MVPDs and OTT Distribution

• Content Production
  • HDR10 is widely used for feature films and scripted TV content
  • HLG is widely used for sports and other live production

• MVPDs and retransmission
  • Pay-TV in the US is evolving to become IP-based, using OTT video streaming technology
  • US cable operators have indicated that they will support HDR10; many are already deploying HDR STBs
    • SCTE technical standards support HDR10 and optional dynamic metadata (DolbyVision** and HDR10+*)

• OTT services
  • HDR10 content (notably feature films and scripted TV) is available on most popular OTT services in the US and growing rapidly
  • HLG is additionally supported on YouTube

*SMPT ST 2094–40 Dynamic Metadata for Color Volume Transform — Application #4  **SMPT ST 2094–10 Dynamic Metadata for Color Volume Transform — Application #1
Conversion Between HDR Systems

- HDR system conversions are complex and imperfect*
  - Conversions between HDR10 and HLG can be performed reasonably well when content is 1,000 nits peak brightness; HLG further limits bright colors
  - Conversion of HDR10 content > 1,000 nits to HLG will require a “grading pass” to make creative decisions on how the high brightness speculars are mapped down
  - In order to best preserve the “creative intent” of content, it’s preferable to perform any HDR system conversion as close to the actual production as practical
  - “Round-trip” conversions may not be transparent and may reduce quality; they should be avoided if possible
  - Further multiple conversions (especially those downstream of production) may further reduce quality and introduce unintended distortions in color

* For details see BT.2390–8 “High dynamic range television for production and international programme exchange” and BT.2408–3 “Guidance for operational practices in HDR television production”
### Broadcast Emission Choices and Conversion Consequences

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<thead>
<tr>
<th></th>
<th>HLG</th>
<th>HDR10</th>
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<tbody>
<tr>
<td><strong>OTA audience</strong></td>
<td>Most scripted content gets converted? Yes</td>
<td>No</td>
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<tr>
<td></td>
<td>Most Live content gets converted?</td>
<td>Yes, at least for some devices <strong>“round trip”</strong> (or convert to SDR)</td>
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<td></td>
<td>Where is conversion?</td>
<td>Where is conversion?</td>
</tr>
<tr>
<td></td>
<td>Who performs?</td>
<td>Who performs?</td>
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<tr>
<td></td>
<td>Comments</td>
<td>Conversion from HDR10 may require re-grading and color correction; esp. if &gt;1000 nits*</td>
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<tr>
<td><strong>Cable Retrans</strong></td>
<td>“round trip” Yes</td>
<td>MVPD ingest</td>
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<td></td>
<td>MVPD</td>
<td>MVPD ingest</td>
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<td></td>
<td>Comments</td>
<td>Blind to “creative intent” (i.e., downstream, not controlled by content producer)</td>
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<tr>
<td><strong>OTT</strong></td>
<td>Yes, at least for some devices <strong>“round trip”</strong> (or convert to SDR)</td>
<td>OTT ingest</td>
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<td>OTT ingest</td>
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<tr>
<td></td>
<td>Comments</td>
<td>Conversion for all devices or dual inventory Blind to “creative intent” (i.e., downstream, not controlled by content producer)</td>
</tr>
</tbody>
</table>

* per BT.2390-8 “High dynamic range television for production and international programme exchange” and BT.2408-3 “Guidance for operational practices in HDR television production”

Note: SL–HDR1 use cases not discussed, but they require the same choice of an HDR system for origination and device–level reconstruction by the receiving device
Some Additional Insights

- Choosing HLG as an emission format optimizes quality for sports/live content delivered to the OTA audience
  - Sports / Live content will undergo a conversion to HDR10 for cable retransmission and streaming and to reach digital devices OTT that are not HLG-capable
  - Downstream conversion to HDR10 by MVPDs will be blind to creative intent of the production*
  - content may look different on OTA compared to retrans and OTT
  - OTT tradeoff between conversion for all devices or dual inventory and conversion for some devices
  - Scripted TV content will undergo a “round trip conversion” that is blind to creative intent*

- Choosing HDR10 as an emission format optimizes quality for scripted content delivered OTA, MVPD retrans and OTT
  - Sports / Live content will undergo a conversion (preferably performed by the content producer)

* e.g., camera setup (white and black levels), camera shading settings, direct comparison of HDR and SDR, etc.

** SL-HDR1 use cases not discussed, but require the same choice of a baseline HDR system for origination and reconstruction by the receiving device
NABA HDR Recommendation

The North American Broadcasters Association

**Considering:**
- That “ATSC Standard: ATSC 3.0 System” (Doc. A/300:2021) states: “All ATSC 3.0 terrestrial and hybrid television services emitted within a given region should use one High Dynamic Range (HDR) system selected for that region from those defined in A/341”;

- That Broadcasters’ goals for an HDR emission include:
  - Providing HDR content to OTA, MVPD retransmission and OTT audiences in the highest possible technical quality and with the greatest possible consideration of future proofing with respect to future advances in both cameras and consumer displays;
  - Reaching the largest possible audience with HDR content (i.e., the broadest possible set of devices via OTA, MVPD retransmission and OTT delivery);
  - Unified HDR and color space formats workflows for broadcast OTA and OTT transmission and emission related workflows;
  - Preserving the highest HDR quality by minimizing the number of conversions that content passes through from creation to consumer display; in particular, avoiding the occurrence of any “round trip” conversions;
  - Minimizing the number of conversion points in the broadcast ecosystem in order to minimize complexity and facilitate the simplest possible flow of content throughout the ecosystem;
  - Ensuring consistent quality and appearance of HDR content, regardless of its delivery path (OTA, OTT or MVPD retransmission);
  - The use of open technical standards;

**Recommends:**
- That systems based on an underlying PQ-based HDR transfer function (SMPTE ST 2084) with optional static (SMPTE ST 2086) [1] and/or dynamic metadata (SMPTE ST 2094) be used for ATSC 3.0 program emission in North America.

[1] CTA defines this, with 10-bit coding, as HDR10.
Thank You