Ultra HD Reality

Thierry Fautier
VP Video Strategy, Harmonic
President, Ultra HD Forum
Agenda

- Status of UHD implementation today
- Looking ahead to UHD Phase 2
- UHD Delivery – what’s missing
- UHD Forum Role
- Moving Forward
### Key UHD Definitions

| **WCG**  
Wide Color Gamut | • BT 2020 color space |
|-------------------|------------------------|
| **HDR**  
High Dynamic Range | • NBC : HDR10 (BDA/DECE)  
• BC (native) : HLG  
• BC (single layer) : Technicolor, Philips, Dolby  
• BC (dual layer) : Dolby |
| **HFR**  
High Frame Rate | • 100 / 120 fps for any resolution:  
  - 1920 x 1080 x 100 / 2560 x 1440 x 100 (level 5.1)  
  - 3840 x 2160 x 100 (Level 5.2) |
| **NGA**  
Next Generation Audio | • Object based coding  
• Immersive audio  
• Interactive audio |
Deployed Ultra HD Services

**United States**
- LIVE: Comcast, Netflix
- VOD: Comcast, Amazon, DIRECTV

**United Kingdom**
- LIVE: BT

**Luxembourg**
- LIVE: SES

**France**
- LIVE: Fransat
- TS Playout: Dalian Tiantu

**China**
- LIVE: Inspur

**Japan**
- LIVE: NHK, NTT, SKY PerfectTV

**Korea**
- LIVE: Skylife, KT, LG U+

**Russia**
- LIVE: Dalian Tiantu

**India**
- LIVE: Videocon, Tata, Sky

UHD Market in Infancy
Harmonic Powers First US UHD Channel

• Ambient video channel with beautiful imagery from the space program
• Harmonic end-to-end UHD video delivery system delivers live and linear 2160p60 NASA content
• A test signal of NASA UHD is currently available on the AMC 18C satellite, with a North American footprint
• HDR 10 (HLG coming) demonstrated at CES’16 together with LG
Harmonic Powers First US UHD Channel

See more at: http://www.harmonicinc.com/resources/videos/nasa-uhd

MILLIONS OF SUBSCRIBERS

2013 2014 2015 2016 2017 2018

Ultra High Definition TV Household Ownership by Region

Household Penetration

North America
Western Europe
Asia Pacific
Central and Latin America
Central and Eastern Europe
Africa Middle East
Global

Sweet Spot

Strategic Analytics, March 15

Top Quality Video: The Emergence of 4K (and 8K) © 2014 Parks Associates
28% of UHD TVs deployed in 2017 are HDR

Need backward compatible scheme with SDR UHD TVs
UHD TV Today

SPECIFICATION

UHDTV1- Phase 1:
- HEVC Main 10 /L5.1
- BT 709
- No HDR
- No HFR
- Legacy Audio

SERVICES

- Mostly OTT
- nVOD
- Few Live services

CHALLENGES

- No buy in from Content Providers
- Broadcasters licenses not available for UHD
- No clear visibility into broadcaster plans
- Lack of HDR standard
- Premium content protection not available
- Service providers waiting for Phase 2

UHD Market Restricted Until Phase 2
What is UHD Phase 2*?

<table>
<thead>
<tr>
<th>ITEM</th>
<th>Phase 1</th>
<th>Phase 2</th>
<th>NOTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deployment</td>
<td>2014 - 2015</td>
<td>2016 - 2018</td>
<td>Services could start earlier</td>
</tr>
<tr>
<td>Codec</td>
<td>HEVC Main 10</td>
<td>HEVC Main 10 Evolution</td>
<td>Decision – June 2015</td>
</tr>
<tr>
<td>Maximum resolution</td>
<td>3840 x 2160 x 60</td>
<td>3840 x 2160 x 120</td>
<td>Multiple profiles</td>
</tr>
<tr>
<td>Maximum MPEG level</td>
<td>5.1</td>
<td>5.1 / 5.2</td>
<td>SMPTE/ITU-R/DVB/ATSC</td>
</tr>
<tr>
<td>WCG</td>
<td>BT 709/ 2020</td>
<td>BT 2020</td>
<td>BC &amp; Non BC</td>
</tr>
<tr>
<td>HDR</td>
<td>No</td>
<td>Several options</td>
<td>Phase 1 TV / Intra HFR</td>
</tr>
<tr>
<td>HFR</td>
<td>No</td>
<td>Several options</td>
<td>BDA/DVB/ATSC</td>
</tr>
<tr>
<td>Backward compatibility</td>
<td>N/A</td>
<td>Yes</td>
<td></td>
</tr>
<tr>
<td>NGA</td>
<td>No</td>
<td>Several options</td>
<td></td>
</tr>
</tbody>
</table>

* As of Oct.30th 2015 9am CET

A Bigger Jump than SD to HD Transition
UHD Phase 2 Challenges

Broadcast decoder needs to support all combinations

ABR decoder can support only selected combinations*

* Pending adequate manifest creation by the Operator
Broadcast Format Interoperability

- UHD SDR STREAM
- UHD HDR STREAM
- LEGACY UHD DECODER
- HDR UHD DECODER
- HDR UHD DISPLAY
- HDR 10 PQ
- Display backward compatible
- Dual Layer (BT2020)
- Hybrid Log Gamma
- Base Layer (BT709)
- SDR (BT709)
- Decoder backward compatible
# Ultra HD Delivery & Standards

<table>
<thead>
<tr>
<th></th>
<th>Broadcast</th>
<th></th>
<th>Multicast</th>
<th></th>
<th>Unicast</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DTT</td>
<td>DTH</td>
<td>Cable</td>
<td>IP QoS</td>
<td>OTT</td>
<td>IP QoS</td>
</tr>
<tr>
<td>DVB-TS</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>DVB DASH</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
</tr>
<tr>
<td>DASH Multicast</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ASTC 3.0 ROUTE</td>
<td>✔</td>
<td></td>
<td></td>
<td></td>
<td>✔</td>
<td>✔</td>
</tr>
</tbody>
</table>

- ✔ Current
- ✔ Extended
- ✔ Not Available
- ✔ Not Relevant for Europe
Growing Community

CHARTER

DOLBY

harmonic

SONY

LG

ERICSSON

comcast

Fraunhofer IIS

NAB LABS

BROADCOM

CONTRIBUTOR

Akamai

NAGRA KUDELSKI

DTG

sky

STI

CableLabs

ARRIS

TPVISION

Envio

VIXS

VANGUARD VIDEO

SIGMA DESIGNS

verimatrix

SKY PerfecTV

AMD

FOX

ASSOCIATE

KEEPixo

B Bright

movie labs

C Tulsa Consulting

NexGuard

NGCODEC

Fairmile West

Unified Streaming

Comunicante Digitale

DVEO

Xvstream
Ultra HD Forum Charter

VISION
Stimulate widespread consumer adoption of UHD and enhanced HD by enabling the availability of compelling content from many sources, including feature films, scripted, and live television content, and its distribution through all current and emerging avenues of delivery to consumers.

GOALS
- Facilitate the development, coordination, harmonization, and adoption of relevant standards and guidelines being developed in various media-related standard organizations and consortia
- Identify guidelines and inform the industry on best practices for the implementation of end-to-end systems for the generation, distribution, and rendering of next generation content
- Ensure handling the needs of real-time workflows with capture of live content for live and on-demand distribution through broadcast, multicast, and unicast deliveries
- Promote and organize Ultra HD media applications, deployments, and successes

DELIVERY
- The Ultra HD Forum is primarily a Business-to-Business (B2B) organization, and is not a Standards Development Organization (SDO)
- Technology is inclusive of ultra high definition resolution, high dynamic range, wide color gamut, high frame rate, advanced audio; the use cases of live, real-time, episodic, on-demand, broadcast, streaming, download and physical media distribution and other related technologies
- Facilitating interoperability tests, plug-fests and trials to demonstrate the usability and comprehensiveness of Ultra HD and related media standards
- Creating a central repository for relevant Ultra HD and related media workflows as well as members products & solutions
- Organizing industry-wide promotion events
- Producing white papers and the organization of informational “Master Classes” at major industry events and the demonstration of end-to-end solutions and proof of concept systems with common content created through diverse workflows
Ultra HD Forum and UHD Alliance are complementary
- UHD Alliance is guaranteeing a consumer experience quality level through a logo program
- UHD Forum is focused on interoperability and best practices for the end to end ecosystem
## Recommendations

<table>
<thead>
<tr>
<th>Item</th>
<th>CES’16 VoD / OTT</th>
<th>NAB’16 Live / Broadcast</th>
</tr>
</thead>
<tbody>
<tr>
<td>Publication</td>
<td>CES’16</td>
<td>NAB’16</td>
</tr>
<tr>
<td>Application</td>
<td>VoD / OTT</td>
<td>Live / Broadcast</td>
</tr>
<tr>
<td>Deployment</td>
<td>2016</td>
<td>2016</td>
</tr>
<tr>
<td>Codec</td>
<td>HEVC Main 10</td>
<td>HEVC Main 10</td>
</tr>
<tr>
<td>Maximum resolution</td>
<td>3840 x 2160 x 60</td>
<td>3840 x 2160 x 60</td>
</tr>
<tr>
<td>WCG</td>
<td>BT 2020</td>
<td>BT 2020</td>
</tr>
<tr>
<td>HDR</td>
<td>ST 2084*</td>
<td>HDR-10/HLG</td>
</tr>
<tr>
<td>Backward compatibility</td>
<td>Receiver based</td>
<td>HE based</td>
</tr>
<tr>
<td>Audio</td>
<td>NGA recommended</td>
<td>5.1</td>
</tr>
</tbody>
</table>

* HDR10, DV, Technicolor-Philips

Good alignment between recommendations
2016 HDR10 Expected Workflow

- HDR-10 Source
- HDR>SDR Converter
- Simulcast
  - HDMI 2.0a
  - HDMI 2.0
- IP QoS
  - Backward Compatible
  - HDR STB
  - HDR TV
  - SDR TV

Encoding is done twice
Conclusions

- Ultra HD Phase 1 had so far a limited success
- Phase 2 brings additional benefits to make it take off
- Phase 2 will require massive Video Work Flow transformation
- Content providers need to clearly understand all the subtleties (HDR, HFR, BC, NGA) and plan a 100 fps / IP workflow
- Europe is behind today in terms of deployments, but leading (DVB, EBU) with a complete Phase 2 ecosystem
- Ultra HD forum will facilitate UHD deployments across all networks

Harmonic is committed to UHD, actively participating to the UHD Forum, MPEG, DVB, ATSC, SMPTE