High Dynamic Range (HDR) in IP TV

introduction of HDR, opportunities and challenges

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Presentation Contents

- Introduction
- What is KPN iTV (and 4K on iTV)
- What would it take to start HDR service?
  - What flavour HDR?
  - Who can be reached?
  - High level Architecture
  - UHD Beyond HDR: High Frame Rate!
KPN
IP TV operator

- KPN is a Telco and IP TV operator
- 1.8 million TV customers
- 20% of Dutch TV market

- Over 200 channels linear TV, radio channels, Pay Per view channels.
- Network/cloud based services:
  - NPVR, Start over TV, replay TV
  - TV Apps including Netflix
KPN UHD services

- KPN has started small scale 4K TV service in 2016
- 1000 UHD STB’s
  - Linear TV (2 channels)
    - Started July 2016 with UEFA Euro 2016 finals live in 4K
    - Video on demand with 4K video’s
    - 4K Video in TV Apps
KPN UHD Set Top Box

- HDMI 2.0 upgradable to HDMI 2.0a and 2.0b
- Capabilities
  - 4K,
  - HDR-10,
  - HLG capable
What is happening
Recent developments

- UHD Forum
- ITU-R BT.2100
- HDMI v2.0b
- DVB Blue Book A157 (TS 101 154)
- 4K HDR ULTRA HD logo: logo for DVB Blue Book A157
# UHD Forum Phase A

## UHD Phase A Definition

<table>
<thead>
<tr>
<th>Feature</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spatial Resolution</td>
<td>1080p* or 2160p</td>
</tr>
<tr>
<td>Color Gamut</td>
<td>BT.709, BT.2020</td>
</tr>
<tr>
<td>Bit Depth</td>
<td>10-bit</td>
</tr>
<tr>
<td>Dynamic Range</td>
<td>SDR, PQ, HLG</td>
</tr>
<tr>
<td>Frame Rate**</td>
<td>24, 25, 30, 50, 60</td>
</tr>
<tr>
<td>Video Codec</td>
<td>HEVC, Main 10, Level 5.1 (single lyr)</td>
</tr>
<tr>
<td>Audio Channels</td>
<td>Stereo or 5.1 multi-channel audio</td>
</tr>
<tr>
<td>Audio Codec</td>
<td>AC-3, EAC-3, HE-ACC, AAC-LC</td>
</tr>
<tr>
<td>Captions/Subs Coding (in/out formats)</td>
<td>CTA-608/708, ETSI 300 743, ETSI 300 472, SCTE-27, IMSC1</td>
</tr>
</tbody>
</table>
ITU-R BT.2100
Image parameter values for high dynamic range television

- PQ (Perceptual Quantization) and HDR10
- HLG (Hybrid Log-Gamma)
- simple conversion process between PQ and HLG.
HDMI
New 2.0b and 2.1 standards

- V 2.0 4K
- V 2.0a 4K and HDR-10
- V 2.0b 4K, HDR-10 and HLG
- V 2.1 4K, HDR-10 and HLG and HFR (120 frames/s)
DVB BlueBook A157 (ETSI TS 101 154)

Phase 2 specified in nov 2016 update of standard

Japan focus
2020

Update DVB
nov. `16
4K HDR ULTRA HD logo
2017 announced European logo

- 4K Resolution 3840 * 2160
- HDR (HDR10 and HLG)
- SDR
- Frame rate up to 50 fps
- HDMI 2.0b
- Seamless transitions:

  - HDR HLG10
  - HEVC
  - SDR
  - HDR PQ10
  - AVC
2016:
30% of all sold new TV sets are UHD
This Figure is growing every month with 3-4 %

- 2013 Introduction of 4K (rec 709)
- 2014 Introduction of 4K with rec 2020
- 2015 introduction of HDR 10
- 2016 introduction of HLG (and Dolby Vision)
Install base UHD TV sets end 2016
Rough estimate colour space
(optimistic scenario)

2016 colour space

- rec 709
- rec 2020

Number of “rec 709 only TVs” is low.
All new TV support rec 2020
Install base UHD TV sets end 2016
Rough estimates 4K only and HDR
(optimistic scenario)

2016 4K versus HDR

- 4k only + rec 2020
- HDR 10
- HDR 10 + HLG

Number of “4K only TVs” is substantial. 4K TV are still being sold today.
There are 6 types of UHDTV panels on the market

<table>
<thead>
<tr>
<th>Year</th>
<th>Panel Types</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>HDMI 1.4, AVC, 8 bit, Rec 709 color space</td>
<td></td>
</tr>
<tr>
<td>2014/2015</td>
<td>HDMI 2.0, HDCP 2.2, AVC, 8 bit, Rec 709 color space</td>
<td>Can support KPN “4K-only” service</td>
</tr>
<tr>
<td>2015/2016</td>
<td>HDMI 2.0, HDCP 2.2, HEVC, 8/10 bit, Rec 2020 color space</td>
<td>Can support KPN “4K-only” service. And can interpret HLG signals.</td>
</tr>
<tr>
<td>2016</td>
<td>HDMI 2.0a, HDCP 2.2, HEVC, 10 bit, Rec 2020 color space, HDR10</td>
<td>First HDR devices on the market. Will render HLG signals as SDR image</td>
</tr>
<tr>
<td>2016</td>
<td>HDMI 2.0b, HDCP 2.2, HEVC, 10 bit, Rec 2020 color space, HDR10, HLG, Dolby Vision</td>
<td>Supports HLG, but needs upgrade to HDMI 2.0b. to support HLG signalling</td>
</tr>
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</table>

2016: First HDR devices on the market. Will render HLG signals as SDR image.
2016: Supports HLG, but needs upgrade to HDMI 2.0b. to support HLG signalling.
Thought Experiment: Start HDR service
Who will be able to see this service?

- 4K HDR
- PQ
- Rec.2020
- 50 Hz
4K HDR (using PQ)

4K HDR PQ
Rec.2020
50 Hz

H.265 HEVC

STB

Ultra HD HDR TV

HDMI2.0a
PQ: 3 out of 6 UHD types
Covering 2/3 of the TV sets in the homes
4K HDR (using HLG)

- 4K HDR
- HLG
- Rec.2020
- 50 Hz

H.265 HEVC

STB

Ultra HD HDR TV

Ultra HD 4K TV (SDR)

HDMI 2.0
HLG: 4 out of 6 UHD types
But 2 types in SDR only

<table>
<thead>
<tr>
<th>Year</th>
<th>Display Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>?</td>
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<tr>
<td>2014/2015</td>
<td>?</td>
</tr>
<tr>
<td>2015/2016</td>
<td>SDR</td>
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<tr>
<td>2016</td>
<td>SDR</td>
</tr>
<tr>
<td>2016</td>
<td>HDR</td>
</tr>
<tr>
<td>2016</td>
<td>HDR</td>
</tr>
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Simulcast
Introduce Safety Net for non HDR viewers

- Down convert HDR to SDR in head end.
- Transmit in simulcast: choose between
  - 4K
  - HD

HD seems the logical choice: Low bandwidth, Higher reach: all existing TV sets
Simulcast 4K HDR (using PQ) and HD

4K HDR
HLG
Rec.2020
50 Hz

→ H.265 HEVC

→ decode

→ Down convert to HD

→ HD 720p
Rec 709
50 Hz

→ H.264 AVC

→ HD STB

→ HD TV

→ UHD STB

→ Ultra HD HDR TV
Simulcast 4K HDR (using HLG) and HD

4K HDR HLG Rec.2020 50 Hz

H.265 HEVC decode

Down convert to HD 720p Rec 709 50 Hz

H.264 AVC

UHD STB

Ultra HD HDR TV

Ultra HD 4K TV (SDR)

HD STB

HD TV
Mapping of 4K PQ and HLG services on UHD TV’s.

<table>
<thead>
<tr>
<th>Year</th>
<th>PQ</th>
<th>HLG</th>
<th>PQ (HD)</th>
<th>HLG (HD)</th>
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<tbody>
<tr>
<td>2014</td>
<td><img src="image" alt="Red TV" /></td>
<td><img src="image" alt="Red TV" /></td>
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High Frame Rate

HDR HFR

DVB Blue Book A157 or ETSI TS 101 154

Released in November 2016 and came with a future option (2018-2019)

- High Frame Rate always in combination with HDR
- Frame rate up to 120 frames/s
- Two HEVC encoding options:
  - Non scalable
  - Dual video pid temporal scalable encoding (*backwards compatible!*)

25 | HIGH DYNAMIC RANGE (HDR) IN IP TV
HIGH DYNAMIC RANGE (HDR) IN IP TV

HDR HFR

4K HDR HFR
Rec.2020
100 Hz

H.265 HEVC

HDMI 2.1

Ultra HD HDR HFR TV

Ultra HD HDR TV

Ultra HD 4K TV (SDR)

HD TV

Frame rate 100 or 120 Hz
Simulcast 4K HDR HFR (using PQ) to 4K HDR and Legacy HD TV sets

4K HDR HFR
Rec.2020
100 Hz

→ H.265 HEVC

→ Reduce frame rate to 50 Hz

→ Ultra HD HDR HFR TV

→ Ultra HD HDR TV

→ decode

→ Down convert to HD 720p Rec 709 50 Hz

→ H.264 AVC

→ HD TV
Simulcast 4K HDR HFR (using HLG) to 4K HDR and Legacy HD TV sets

4K HDR HFR
Rec.2020
100 Hz

H.265 HEVC

Reduce frame rate to 50 HZ

H.264 AVC

HD TV

Ultra HD HDR HFR TV

Ultra HD HDR TV

Ultra HD 4K TV (SDR)
Simulcast 4K HDR HFR (using HLG) to 4K HDR and Legacy HD TV sets

4K HDR HFR
Rec.2020
100 Hz

H.265 HEVC
Dual pid
temporal
scalable

decode

Down convert to
HD
720p
Rec 709
50 Hz

H.264 AVC

Ultra HD
HDR HFR TV

Ultra HD
HDR TV

Ultra HD
4K TV
(SDR)

HD TV
Conclusions

- Both HDR10 and HLG are candidate solutions for IP TV distribution.
- HDR services will only reach latest TV sets (with HDR support).
- Simulcast in SDR 4K or SDR HD can be used as backwards compatibility option to reach all screens.
- Future introduction of HFR services potentially create similar problems and outdate TV sets sold today.
Thank you
For your attention