High Dynamic Range in AV1

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Why Codecs?
Unlock The World
Unlock
The Future

IBC 2018
Track Record: VP9 + YouTube

YouTube VP9 watch time gains vs. H.264
Who is

Founded in Fall 2015, 36 companies came together to develop next generation codecs for the web.
Goals for Video Codec for the Web
With state of the art compression efficiency
Open source & royalty-free
Grounded in the WebM philosophy
Deploy Widely & Quickly
Developed faster than standards bodies and supported across platforms
VOD Services

Member companies with video-on-demand streaming consumer products & services.
Live/RTC Services

Member companies with live streaming and/or real time communication consumer products & services.
Results: BITMOVIN

Average weighted PSNR BD-rate delta of AV1 vs HEVC

<table>
<thead>
<tr>
<th>Resolution</th>
<th>Delta</th>
</tr>
</thead>
<tbody>
<tr>
<td>all</td>
<td>17.08%</td>
</tr>
<tr>
<td>&gt;= 720p</td>
<td>37.81%</td>
</tr>
<tr>
<td>&gt;= 1080p</td>
<td>30.90%</td>
</tr>
<tr>
<td>&gt;= 1440p</td>
<td>34.04%</td>
</tr>
<tr>
<td>&gt;= 2160p</td>
<td>43.90%</td>
</tr>
</tbody>
</table>
Results: facebook

AV1 BD-rate saving in terms of PSNR for CRF/QP mode

-360p: -42.2%, -39.8%
-480p: -49.3%, -44.0%
-720p: -49.9%, -45.0%
-1080p: -58.9%, -54.6%
-Average: -50.0%, -45.8%

x264 Main  x264 High  lbrp-xvp9
Results:
Where We Are

1. Tools Selected (Completed)
2. Codebase frozen (Completed)
3. Spec Published (Completed)
4. Support in Chrome (Q3 2018)
5. SoC Hardware (2020)

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Google is Committed to AV1
Demo

• Download Chrome Canary / Dev Channel

• "Enable AV1 Video Decoding" to "Enabled" in chrome://flags

• Playback
More Demos!

Check out our partners’ demos here at IBC2018

BOOTH SU10725MR
BOOTH SU3710
BOOTH SU9901

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Learn More

- Project Site: https://aomedia.org
- Source code: https://aomedia.googlesource.com/
- Bitstream specification: https://aomedia.org/av1-bitstream-and-decoding-process-specification/
High Dynamic Range in AV1

An Alternative Future for HDR
The real world

Very wide range of lighting

× Peak luminance is NOT 1,000 or even 10,000 nits
✓ Need to be “scene-referred”

A single candle lit in a dark room has a dynamic range
16.8 million to 1 (24 stops)
HD-TV 1000pxl

UHD-TV 4000pxl

Wow! 4K!

Colour Gamut

35% 85%

50 fps

Now with 10,000 Nits

120 fps

© COST Action IC1005 2015
What we did

- Added existing HLG and PQ (HDR10)
- New HDR methods – scene referred
  - PTF (Gamma) – real-time, on-the-fly adaptive to:
    - ambient light, creative intent, display luminance
- Ratnajit – faithfully preserves colour
Why

✓ Scene referred
✓ HDR viewed under “normal” ambient lighting
✓ Future proof
Complexity

\[ PQ_{\text{forward}}(V) = \left( \frac{V^{1/m_2} - c_1}{c_2 - c_3 V^{1/m_2}} \right)^{1/m_1} \]

where: \( m_1 = \frac{2610}{4096} \times \frac{1}{4}, m_2 = \frac{2523}{4096} \times 128, c_1 = \frac{3424}{4096}, c_2 = \frac{2413}{4096} \times 32, c_3 = \frac{2392}{4096} \times 32 \)

\[ HLG_{\text{encode}}(V) = \begin{cases} \sqrt[3]{V} & V \leq 1 \\ a \log(V - b) + c & V > 1 \end{cases} \]

where: \( r = 0.5, a = 0.17883277, b = 0.28466892, c = 0.55991073 \)

\[ PTF_{\gamma}(V) = V^{d/\gamma} \]

where: \( \gamma = \text{variable}, V \) is normalised HDR
Performance

Figure 3: Difference in decoding time in frames per second between PTF_4, PQ and a generic LUT (PTF_4 in this case) across a range of sequence and averaged over 5 tests per sequence on a workstation PC (Higher is better).
Not in a dark room

outside
80,000 lux

4,000 nits
10,000 nits
HDR in AV1
An Alternative Future for HDR!

- Open, royalty-free HDR video coding
- No more watching HDR in the dark
- High quality, efficient codecs
- Wide scope of devices and platforms

University of Warwick (UK) | trueDR (UK) | Google (US) | SIM2 (IT) | ORF (A) | Vicomtech (ES)
“See! I told you there is another springbok in the shade!”
HDR-AV1 is here

➢ For TVs, movies …
Even (shortly) for mobile devices …