HIGH EFFICIENCY VIDEO CODING
MASTER CLASS

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Ericsson
High Efficiency Video Coding (HEVC):
A new standardized compression algorithm
- An evolution of AVC (H.264 | MPEG-4 Part 10)

From the Joint Collaborative Team on Video Coding (JCT-VC) of MPEG & VCEG

Aim: To deliver same picture quality for half the bitrate of AVC
- Up to 10x more computational complexity to encode and 2x-3x to decode

HEVC DEVELOPMENT TIMELINES

HEVC
“Main” – 4:2:0 8 bit
“Main 10” – 4:2:0 10bit

HEVC REXT
Range EXTensions
12bit / 14bit
4:2:2 / 4:4:4

SHVC
Scalable High Efficiency Video Coding

Jan 13
Jul 13
Jan 14
Jul 14

Decoder Timescales

› Broadcast profiles now released

› Software decoders – 2013
  – Multi-core ARM processors
  – Smartphones, Tablets, Smart TVs products announced for 2013 release

› Hardware decoders - end 2013 - mid 2014
  – STBs estimated mid-end 2014
HIGH EFFICIENCY VIDEO CODING COMPRESSION BITRATE TARGETS

- 50% bitrate saving – Direct-to-home
- 30% bitrate saving – Contribution

- MPEG-2 VIDEO 1994
- AVC 2003
- HEVC 2013

Bitrate

1995 2005 2015
**HEVC Potential - Direct-to-Home for Similar Picture Quality**

<table>
<thead>
<tr>
<th></th>
<th>MPEG-2 Video</th>
<th>AVC</th>
<th>HEVC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SD</strong></td>
<td>3 - 5 Mbps</td>
<td>1.5 - 2.5 Mbps</td>
<td>0.8 - 1.5 Mbps</td>
</tr>
<tr>
<td><strong>HD</strong></td>
<td>12 - 18 Mbps</td>
<td>6 - 9 Mbps</td>
<td>3 - 4.5 Mbps</td>
</tr>
<tr>
<td><strong>4K UHDTV (2160p60 10b)</strong></td>
<td>N/A</td>
<td>16 – 30 Mbps (theory)</td>
<td>8 – 15 Mbps*</td>
</tr>
</tbody>
</table>

*Fits in existing channel bandwidth of currently deployed HD!
# HEVC Potential - Contribution for Similar Picture Quality

<table>
<thead>
<tr>
<th></th>
<th>MPEG-2 Video 4:2:2 8b</th>
<th>AVC 4:2:2 10b</th>
<th>HEVC 4:2:2 10b</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HD</strong></td>
<td>35 - 60 Mbps</td>
<td>20 - 40 Mbps</td>
<td>14 - 28 Mbps**</td>
</tr>
<tr>
<td><strong>4K UHDTV (2160p60)</strong></td>
<td>N/A</td>
<td>100 - 200 Mbps*</td>
<td>50 - 100 Mbps**</td>
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</tbody>
</table>

*4 x 1080p60
**Estimated; HEVC Range Extension profiles not yet standardized
High Level Tool Comparison

**AVC**
- 16x16 block size
- Various Inter partitions down to 4x4
- 9 intra modes
- 8x8 and 4x4 transform sizes

**HEVC**
- 64x64 block size
- Hierarchical quad-tree partitioning down to 8x8 + 4x4 Transform Units
- 35 intra modes
- 32x32, 16x16, 8x8 and 4x4 transform sizes
INDUSTRY DRIVERS - EFFICIENCY

Mobile TV
• Expensive bandwidth
• Increasing demand

Multi-screen
• More HD
• More screens

dxDSL reach
• More subscribers

DSNG
• More HD
• Expensive bandwidth

Satellite Distribution
• Spectrum efficiency

UHDTV
• High bit-rate need

Terrestrial Broadcast
• Spectrum efficiency
HEVC PRACTICAL AVAILABILITY

- Driven by availability of receive devices
- First version of standard completed January 2013
- Software-based implementations available now
  - But only address a subset of applications (Mobile broadcast & OTT)
- 1st production silicon available during 2013
  - But does not support true 4K UHDTV, 10-bit, and some other facets
- 2nd production silicon available 1H2014
  - 1st practical systemization 4Q14-1H15
- Implementation issues (impacts practical ability to deploy)
  - Migration of deployed (legacy) vs. greenfield
  - Intellectual property licensing needs to be settled → MPEG LA
  - 4K UHDTV: Main 10 Profile settled but what higher frame rate?
  - Better interlaced content support?
  - 1st systemization 1H15
## Projected HEVC Adoption

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<td>News Gathering</td>
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<td>Events</td>
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<td>Trial</td>
<td>Early Adopter</td>
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<td>Content Exchange</td>
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<tr>
<td>Content Distribution</td>
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<td>Multi-Platform Video Processing</td>
<td>Cable &amp; Sat DTH</td>
<td>Trial</td>
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<tr>
<td>Telco / IPTV</td>
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<td>DVB-T2</td>
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<td>UHDTV Live DTH</td>
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<td>Trial</td>
<td>Early Adopter</td>
<td>Mainstream</td>
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<tr>
<td>Multi-Screen Video Processing</td>
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<td>Trial</td>
<td>Early Adopter</td>
<td>Mainstream</td>
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<tr>
<td>LTE for Broadcast</td>
<td>HEVC for Mobile</td>
<td>Early Adopter</td>
<td>Early Adopter</td>
<td>Mainstream</td>
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DRIVING UHDTV CONTENT & EVENTS

Movies

TV dramas

Live sports

2014

TIME TO PLAY
SPORTS REQUIRE “TRUE” 4K UHDTV

UHDTV is effectively 4x1 HD spatial resolution but that’s not the entire story ...
VISUAL QUALITY - IMMERSIVE EXPERIENCE

Central field of vision - 90°
VISUAL QUALITY - IMMERSIVE EXPERIENCE

Central field of vision - 90°
VISUAL QUALITY – FRAME RATES

› UHDTVs’ field of view will occupy typically 60°
  – As a result of increased screen size

› Motion judder is caused by angular change
  – Larger displays mean a need for increased frame rate
  – A function of linear TV size

› 4K UHDTV
  – Will benefit from 2x frame rate versus HD
    › Therefore 50fps and 59.94/60fps are ideal
  – Higher frame rates are being debated …
    › Motion judder concern has been demonstrated
    › Also some risk of impairment from camera CCD noise
    › 100-150fps currently under industry research

› Wider field of view also means wider camera angles
UHDTV LIKELY TO BE 10-BIT TO HOME

› Banding (posterization) with 8b, especially in plain areas
  - Sky, backgrounds, graphics, logo
  - More noticeable with slow changes, such as fades

› Also the minimum bit depth for High Dynamic Range (new study item)
WHAT FORMAT WILL INDUSTRY SETTLE ON FOR 4K UHDTV?

4K HEVC requires up to 80x more processing power vs. HD AVC

… and this discussion has not included the audio delivery format for UHDTV!
HEVC SUMMARY

› HEVC is an exciting new standardized codec that has greatly improved bandwidth efficiency:
  − ½ the bitrate of AVC
  − ¼ the bitrate of MPEG-2 Video

› HEVC roll-out will occur at different times for different market segments
  − Requires mature ecosystem to be in place
    › New set-top boxes / TV receivers → new HEVC chipsets
  − For legacy, requires significant bitrate savings for ROI
  − First segments: LTE Broadcast and Over-the-Top (multi-screen)
  − Later: Direct-to-Home and Contribution