

The Story After HEVC

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<https://tinyurl.com/yep9uypw>

Beginning - Do you notice what the codecs are used in ...

- YouTube
- Netflix
- Twitch
- ...

What is current situation of the codecs?
Support of each browser as an example

H.264 support in browsers

Spec	http://ip.hhi.de/imagecom_G1/assets/pdfs/csvt_overview_0305.pdf
Status	Other

IE	Edge	Firefox	Chrome	Safari	Opera
			100		
		97	99		
		96	98	TP	
11	97	95	97	15.2	82
10	96	94	96	15.1	81
9	95	93	95	15	80
8	94	92	94	14.1	79
Show all					

VPx support in browsers

Spec	https://www.webmproject.org [↗]
Status	Other

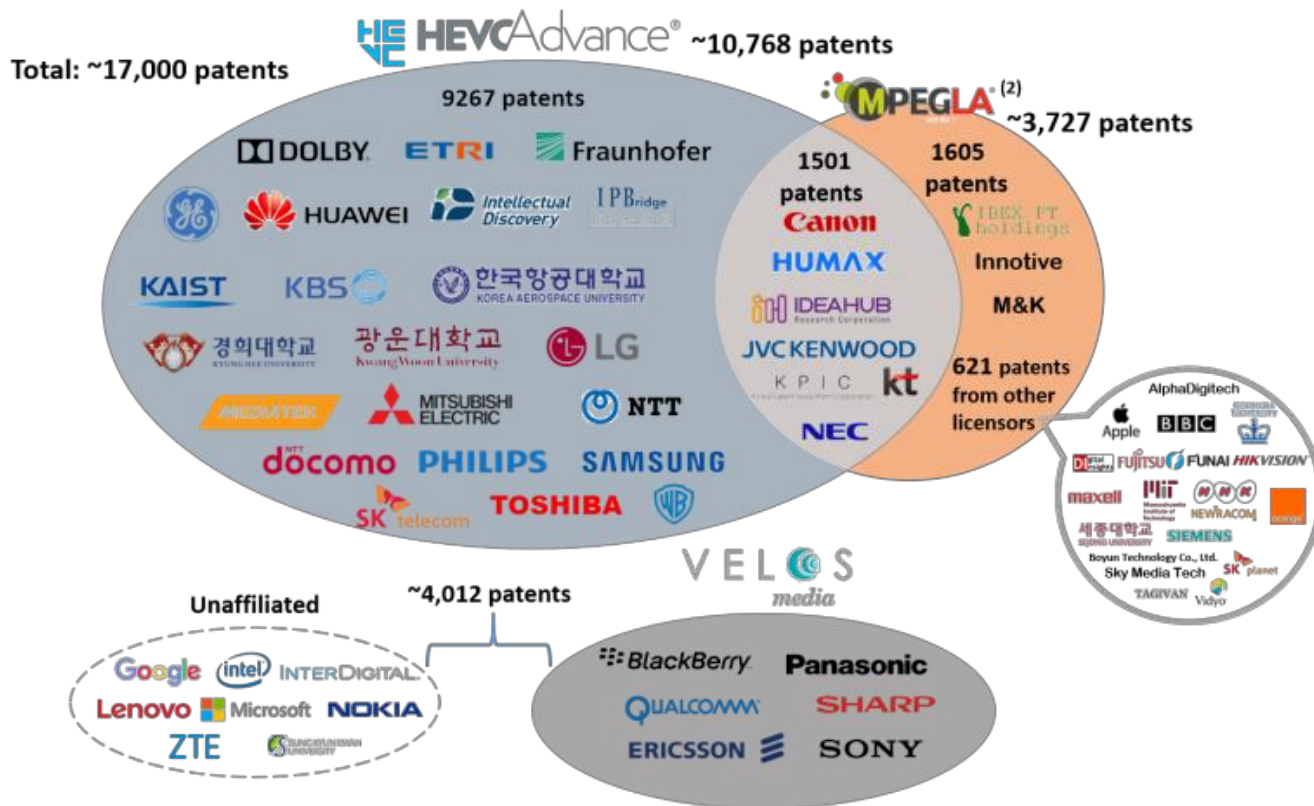
IE	Edge	Firefox	Chrome	Safari	Opera
			100		
		97	99		
		96	98	TP ⁽⁷⁾	
11 ⁽³⁾	97	95	97	15.2 ⁽⁷⁾	82
10 ⁽³⁾	96	94	96	15.1 ⁽⁷⁾	81
9 ⁽³⁾	95	93	95	15 ⁽⁷⁾	80
8	94	92	94	14.1 ⁽⁷⁾	79
Show all					

HEVC support in browsers

Spec	https://www.itu.int/rec/T-REC-H.265 [↗]
Status	Other

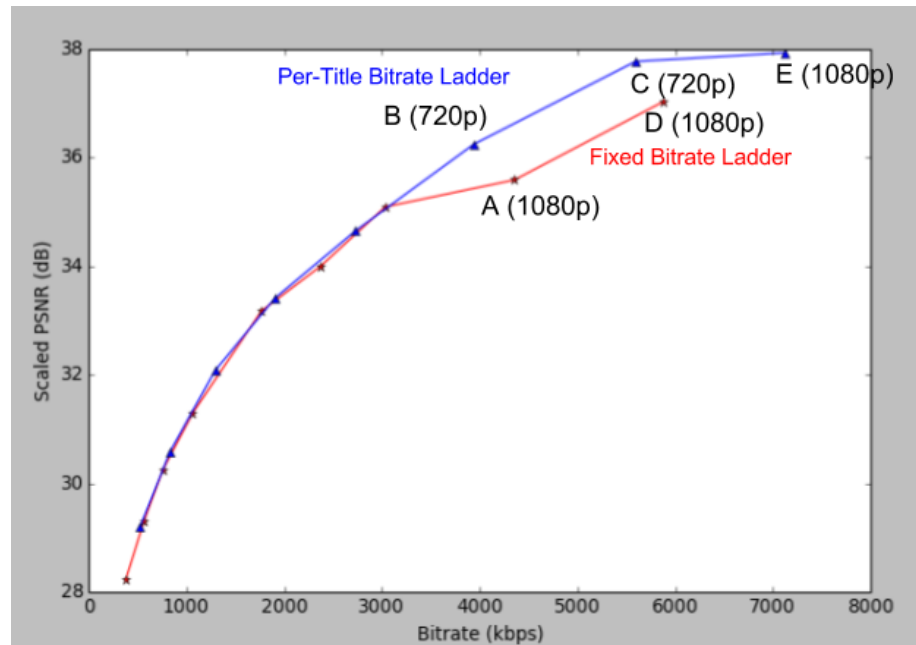
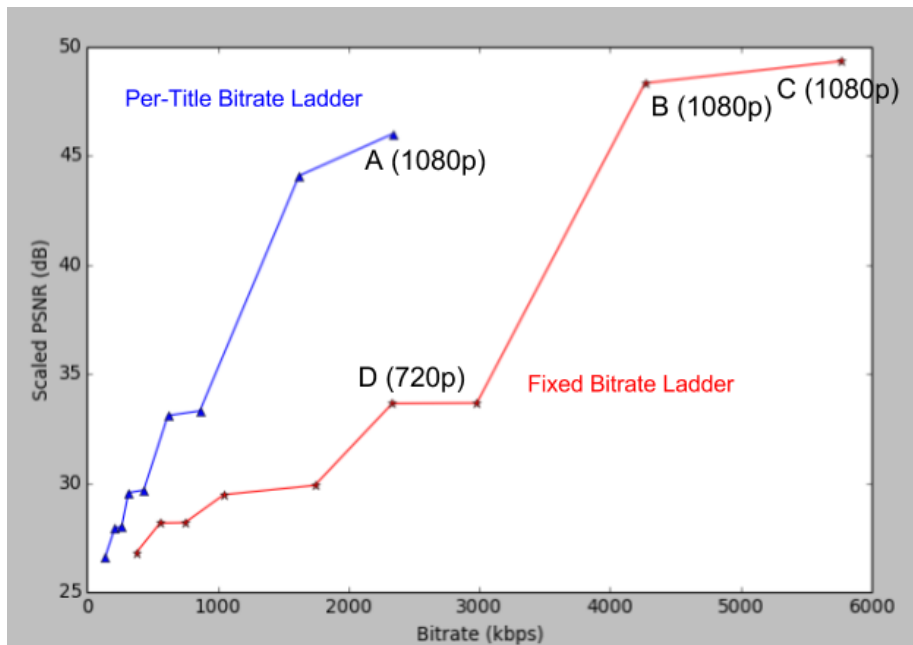
IE	Edge	Firefox	Chrome	Safari	Opera
			100		
		97	99		
		96	98	TP	
11 ⁽¹⁾	97	95	97	15.2	82
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Show all					

The issue - HEVC patent pools

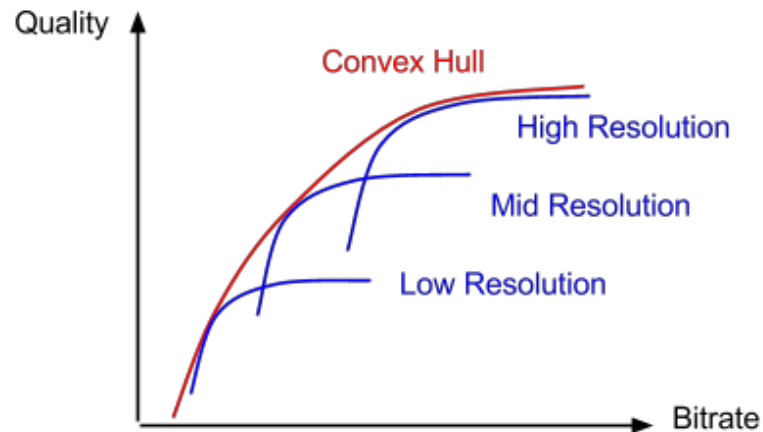
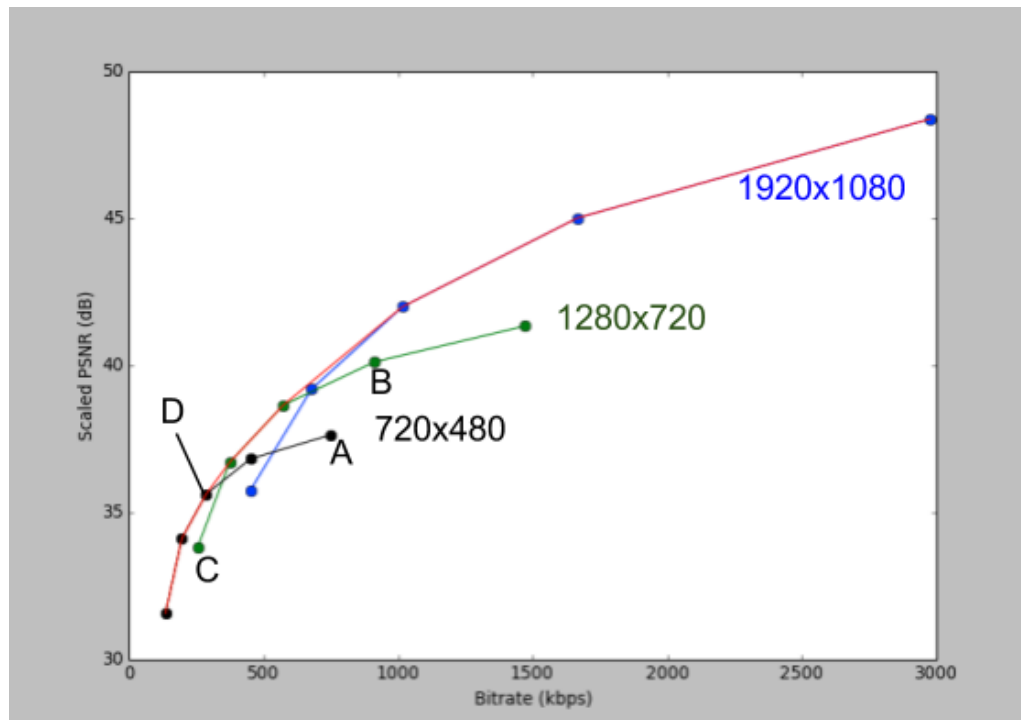


Any optimization method
for current codec?

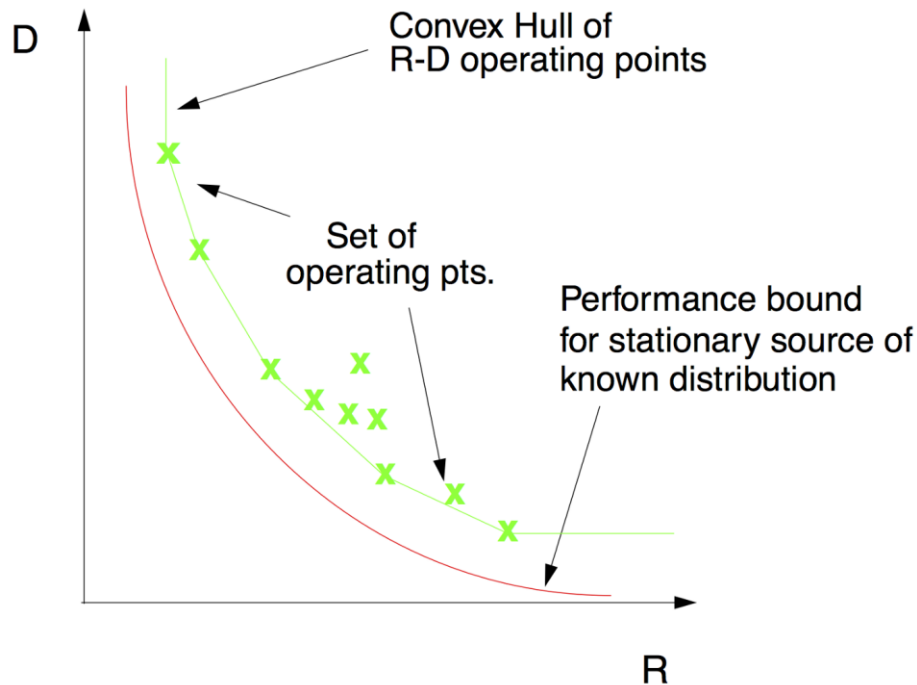
Per-Title Encode Optimization



Per-Title Encode Optimization (cont.)



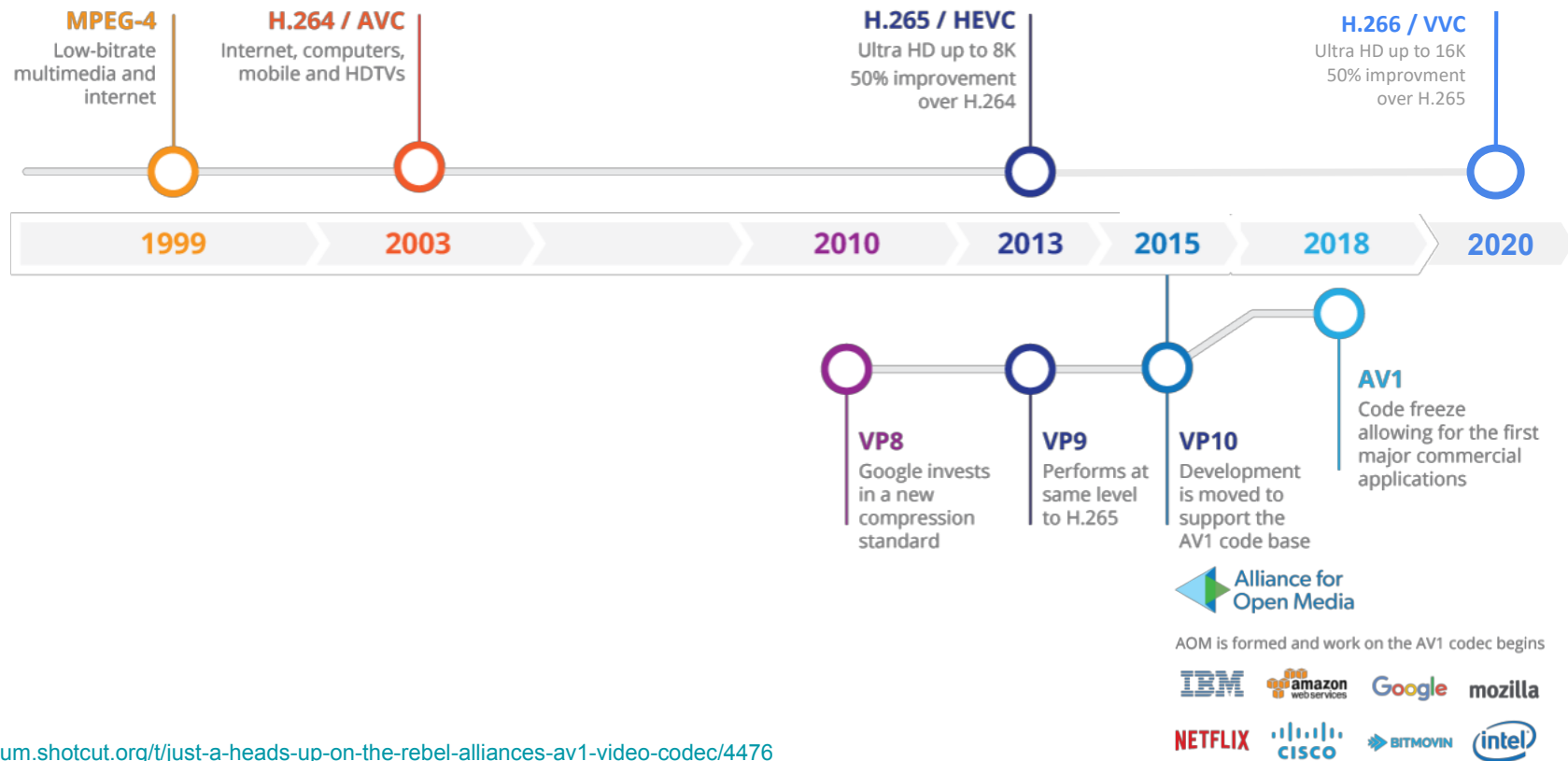
Dynamic Optimization



<https://netflixtechblog.com/dynamic-optimizer-a-perceptual-video-encoding-optimization-framework-e19f1e3a277f>

<https://netflixtechblog.com/optimized-shot-based-encodes-now-streaming-4b9464204830>

Timeline of Video Codecs



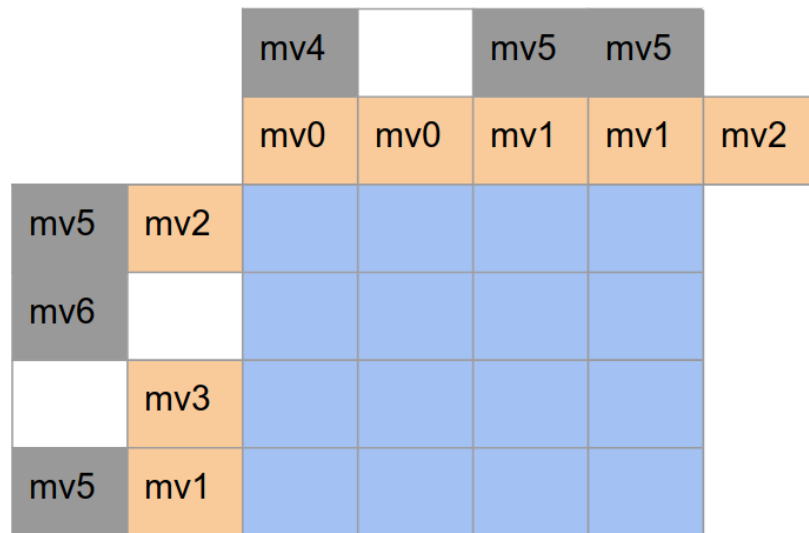
AV1 - Here Comes A New Challenger!

AV1 Inter Prediction

Dynamic Reference Motion Vector Prediction (REFMV)

- Specify the index of a MV from a list of MVs computed from neighbors
 - Examine MVs at the 8x8 block level
- Rank the MVs in the list by:
 - Distance from current block
 - Amount of overlap with current block
- Encode the index of the selected MV

Category 1	Category 2
mv1, mv0, mv2, mv3	mv5, mv4, mv6



AV1 Inter Prediction

Global & Warped Motion

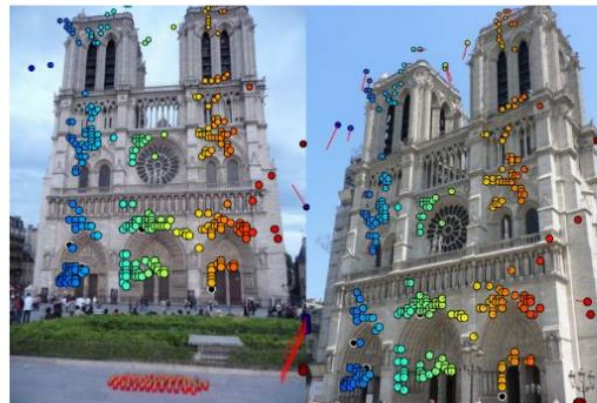
- Global Motion:
 - GM parameters computed for each reference frame using feature matching + RANSAC
 - Supported motion models (& DoF):
 - Translation (2), similarity (4), affine (6), homographic (8)
- Warping:
 - Implemented as 2 shears:
 - Using 8-tap filters
- Motion parameters coded in the bitstream

$$\begin{bmatrix} a & b \\ c & d \end{bmatrix} = \begin{bmatrix} 1 & 0 \\ \gamma & 1 + \Delta \end{bmatrix} \begin{bmatrix} 1 + \alpha & \beta \\ 0 & 1 \end{bmatrix}$$

Original warping matrix Vertical Shear Horizontal Shear

Combined GM + WM + OBMC

-> 2.0 - 6.0% gain (esp. Handheld camera)



Constrained Directional Enhancement Filter (CDEF)

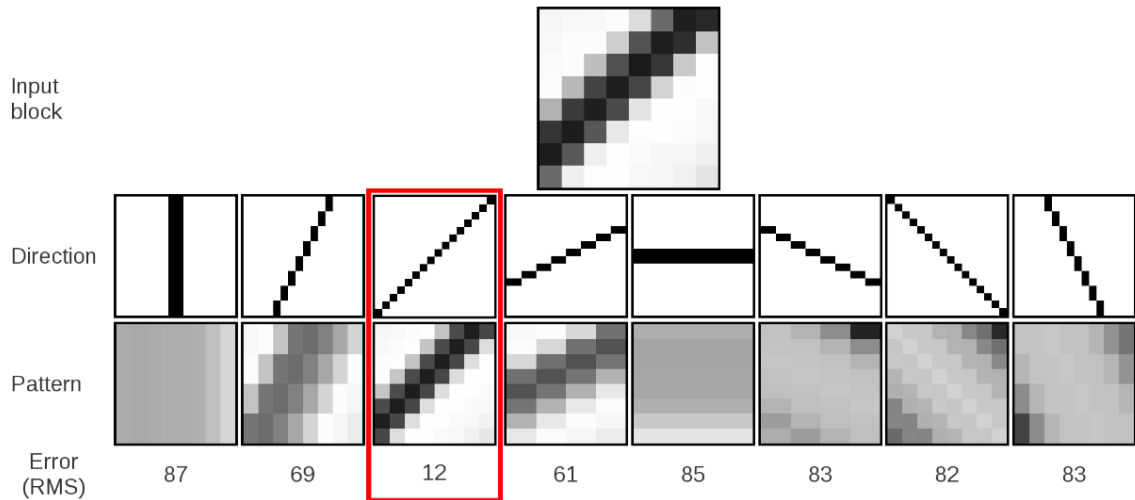
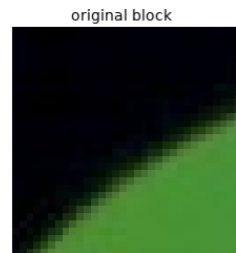
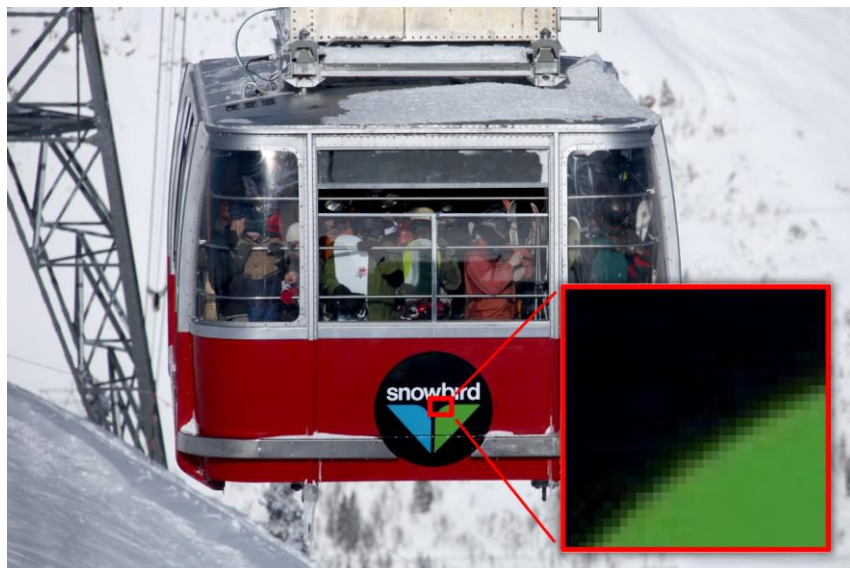
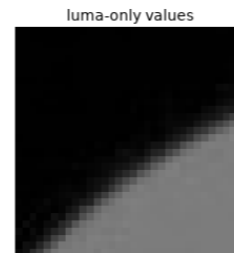


Fig. 2. Example of direction search for an 8×8 block. The patterns shown are based on the $\mu_{d,k}$ values. In this case, the 45-degree direction is selected because it minimizes E_d^2 . The error values E_d shown are never computed in practice (only s_d is).

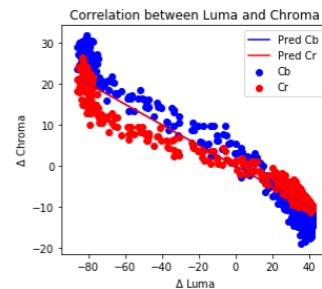
Chroma from Luma



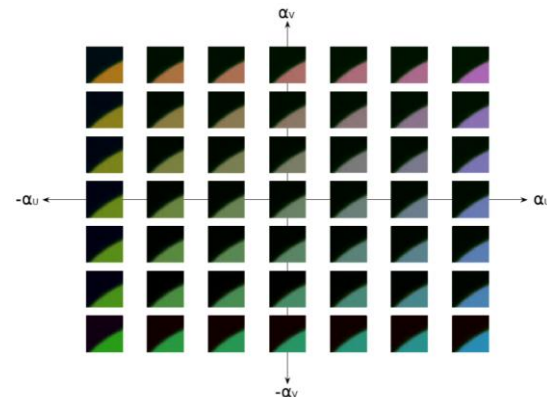
Size: 32 x 32



Size: 32 x 32



Above: Cb and Cr (U and V) values plotted versus luma (Y) for pixels in the highlighted block from the previous picture. A quantized and encoded straight-line model fit is superimposed over the scatterplot as a line. Note that a fit consists of two lines; in this example, the lines are superimposed.



Above: Cb's α parameters select a hue for block colorization from a 2D color plane.

AV1 support in browsers

Spec	https://github.com/AOMediaCodec/av1-spec
Status	Other

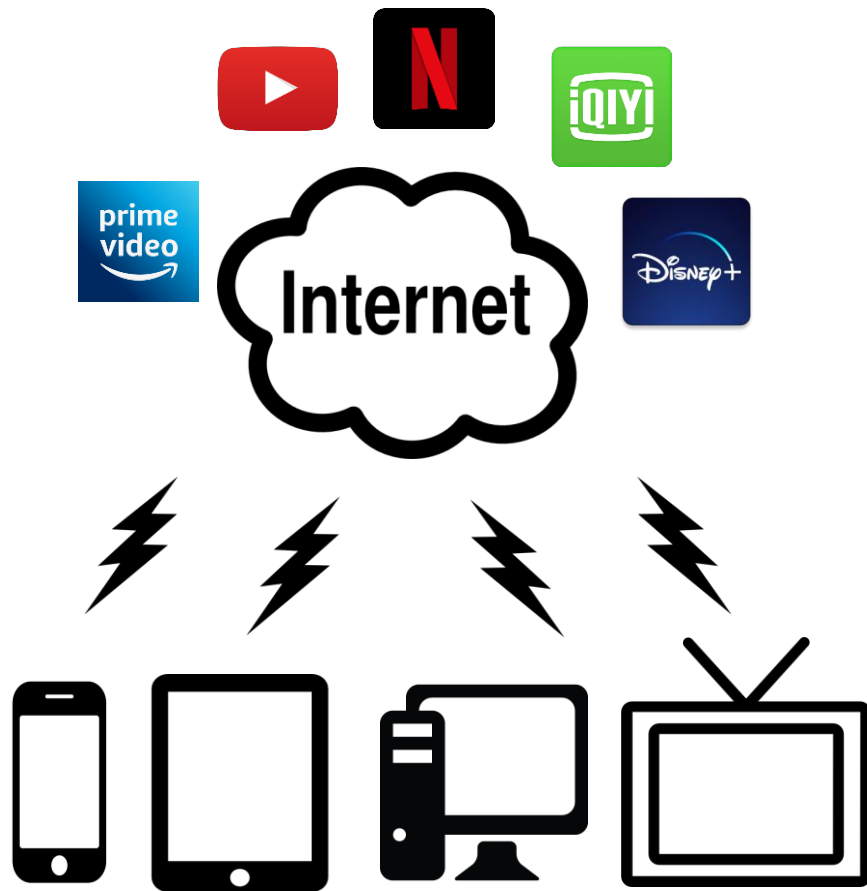
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Show all					

“At long last everybody realises that the old MPEG business model is now broke, all the investments (collectively hundreds of millions USD) made by the industry for the new video codec will go up in smoke and AOM’s royalty free model will spread to other business segments as well.” - **Leonardo Chiariglione**

<https://blog.chiariglione.org/a-crisis-the-causes-and-a-solution/>

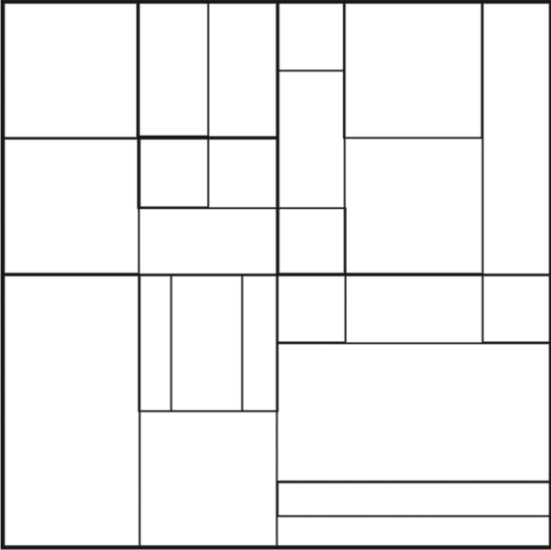
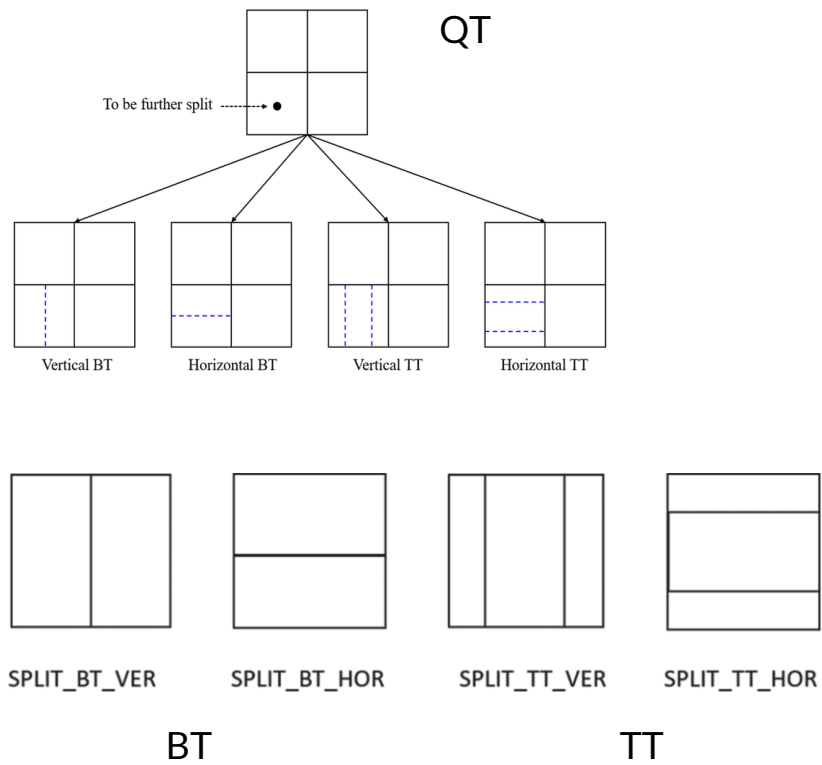
<https://blog.chiariglione.org/a-future-without-mpeg/>

What Happened? (IMHO)

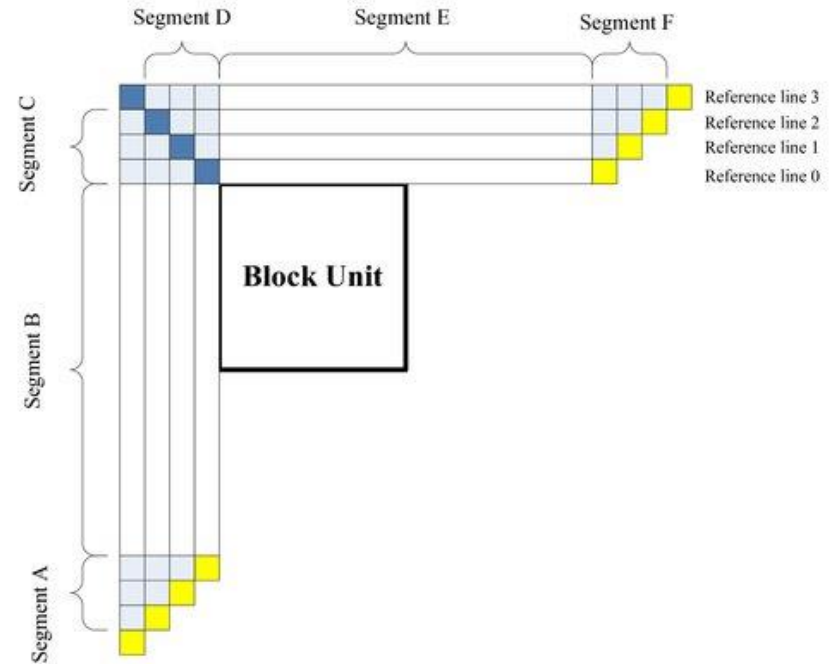
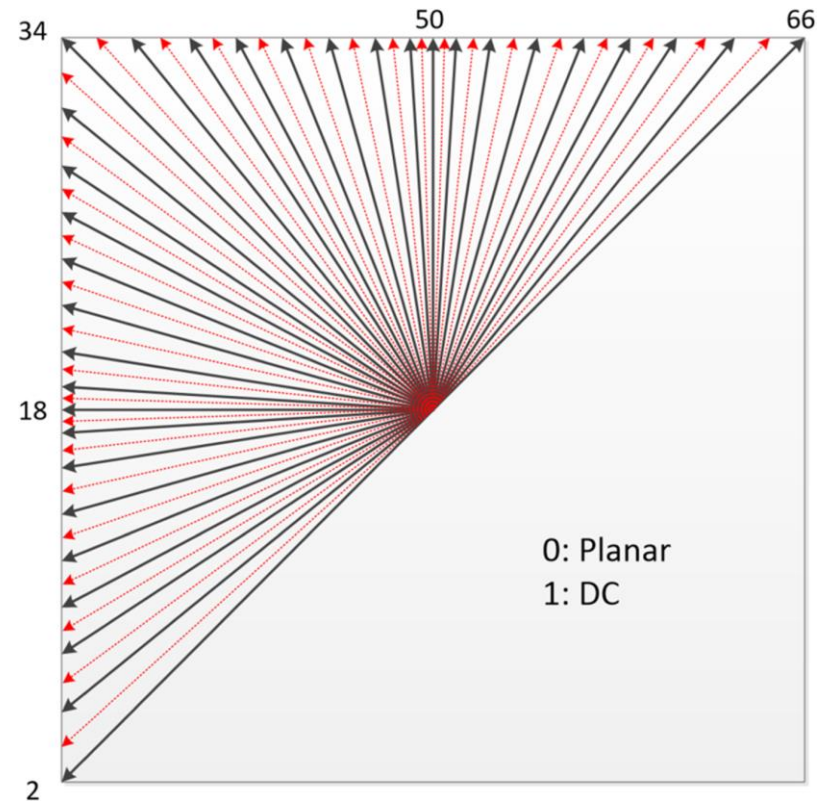


VVC - MPEG latest effort

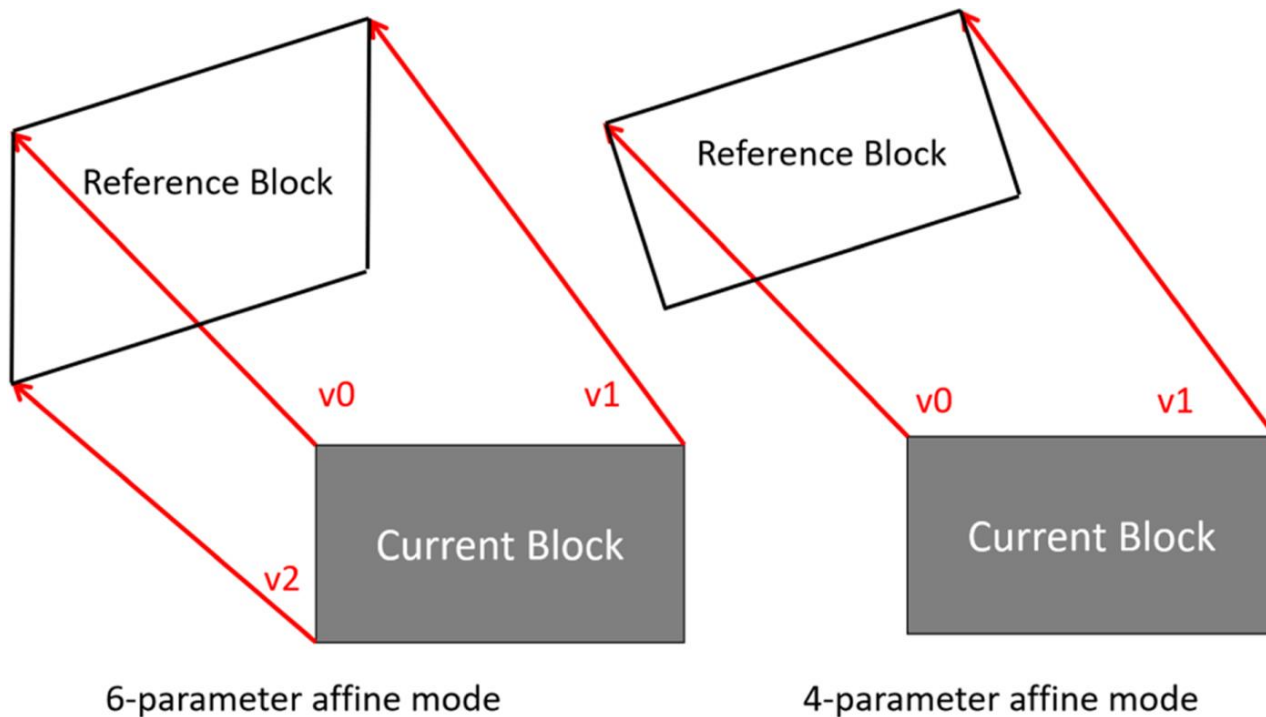
Block Partition / Structure



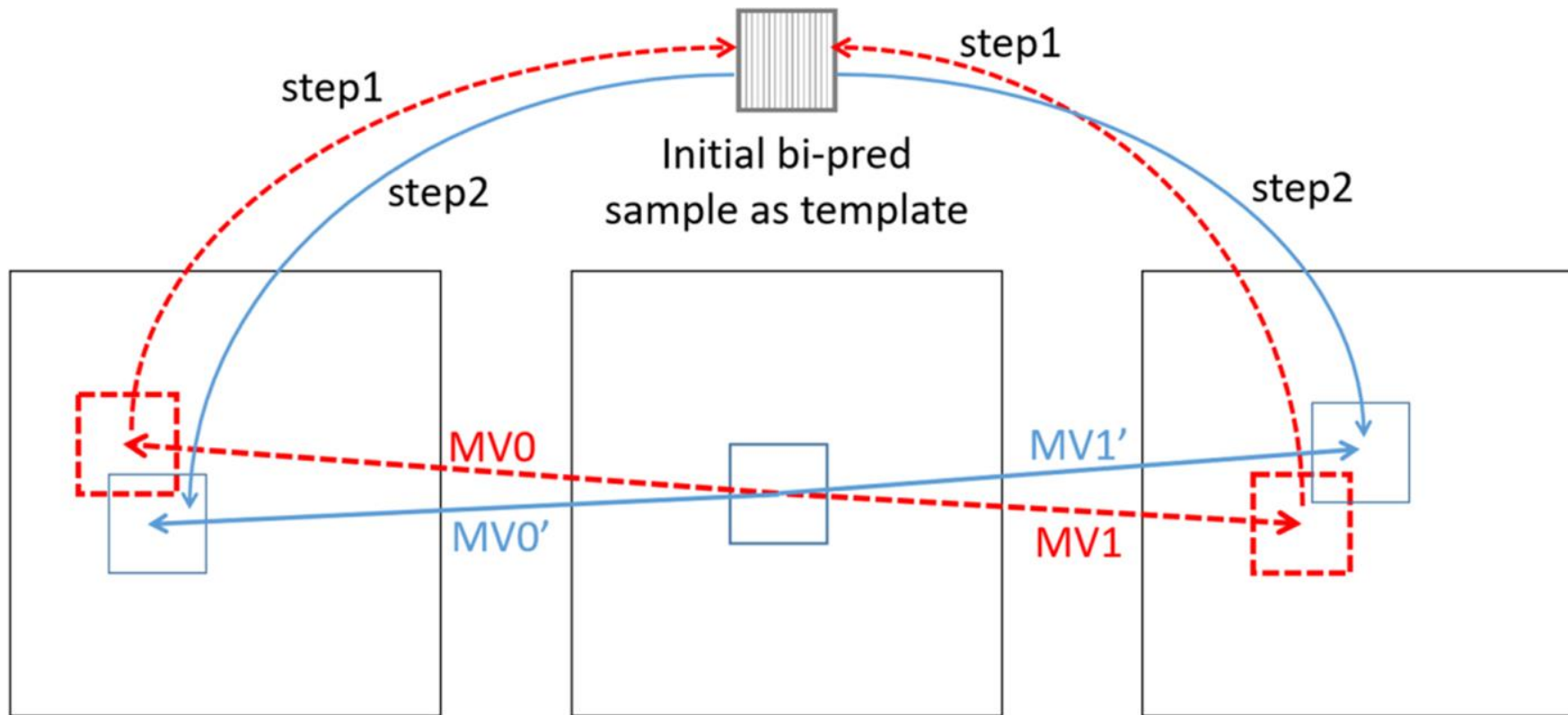
Intra Prediction



Inter Affine Motion Compensation



DMVR - Decoder-side MV Refinement

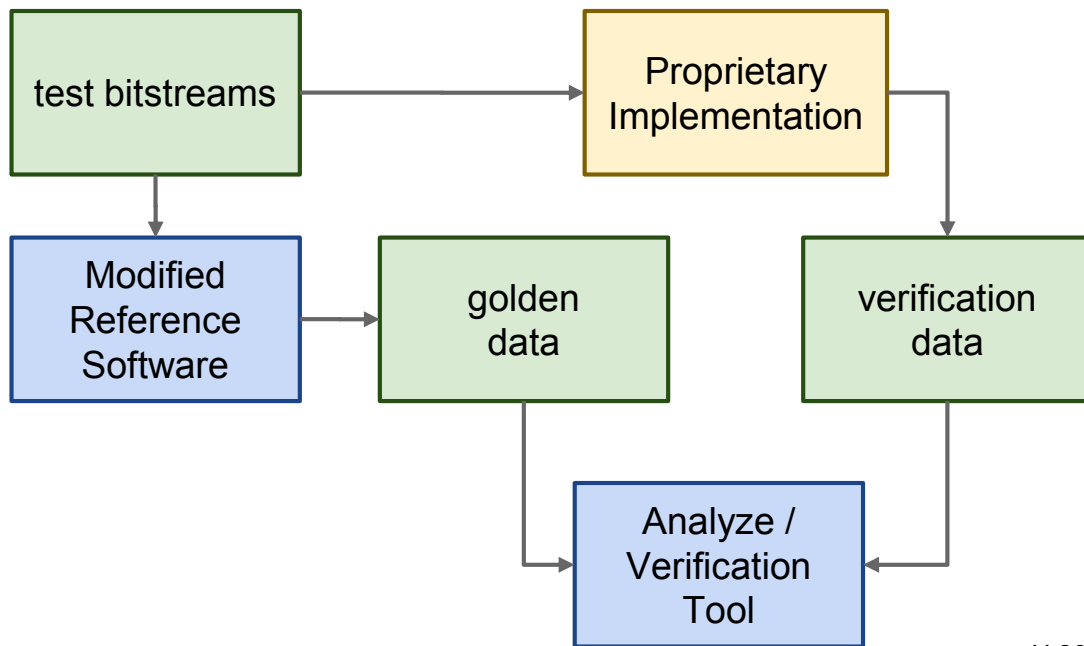


Transform

Transform Type	Basis function $T_i(j)$, $i, j = 0, 1, \dots, N-1$
DCT-II	$T_i(j) = \omega_0 \cdot \sqrt{\frac{2}{N}} \cdot \cos\left(\frac{\pi \cdot i \cdot (2j + 1)}{2N}\right)$ where, $\omega_0 = \begin{cases} \sqrt{\frac{2}{N}} & i = 0 \\ 1 & i \neq 0 \end{cases}$
DCT-VIII	$T_i(j) = \sqrt{\frac{4}{2N + 1}} \cdot \cos\left(\frac{\pi \cdot (2i + 1) \cdot (2j + 1)}{4N + 2}\right)$
DST-VII	$T_i(j) = \sqrt{\frac{4}{2N + 1}} \cdot \sin\left(\frac{\pi \cdot (2i + 1) \cdot (j + 1)}{2N + 1}\right)$

How to develop a HW codec?

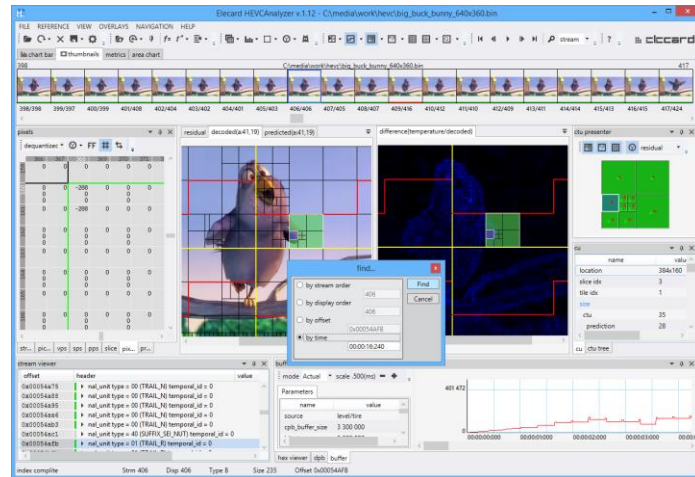
Development Workflow



H.264 JM: <http://iphome.hhi.de/suehring/tml/>
HEVC HM: <http://hevc.hhi.fraunhofer.de/>
VVC VTM: <https://jvet.hhi.fraunhofer.de/>

Tools / Bitstreams

- In-House Developed
 - Modified Reference SW Encoder / Decoder
- Commercial Tools
 - [Allegro DVT](#)
 - [ViCueSoft](#)
 - [Argon Design \(Acquired by Broadcom\)](#)
- Manufacturer BitstreamTest Set
 - Customer Issues
 - Broadcast Streams



Thank you, Q & A