Codecs in 2018 and Beyond

In 30 Minutes or Less

by Jan Ozer
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Agenda

- Codecs (25 Minutes)
  - H.264
  - HEVC
  - Google VP9
  - Alliance for Open Media AV1
  - V-Nova PERSEUS
  - Divideon xvc
- Questions (5 Minutes)

H.264

- What’s it give you?
- What’s it cost you?
- The big question: How much longer will you continue to encode H.264?

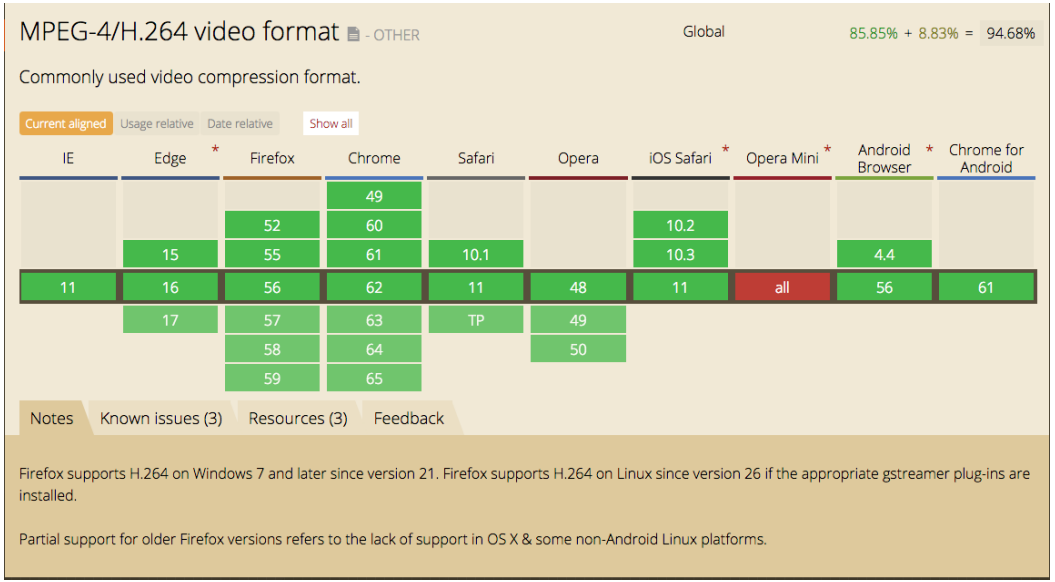
H.264: What's it Give You?

- Ubiquitous compatibility
- Live and VOD

H.264: HEVC Browser and Mobile (www.caniuse.com)

Supported Platforms

- Nearly ubiquitous support over all desktop and mobile OS and browers



H.264 Compatibility Matrix

OTT	**H.264**
Roku	Yes
Chromecast	Yes
FireTV	Yes
Apple TV	Yes
Smart TV	
Samsung	Yes
HbbTV	Yes
Smart TV Alliance	Yes

H.264:Live Transcoding - Available for all Formats

This is Wowza; Nimble Streamer as well.

Video Output	H.264
Adobe RTMP	✓
RTSP/RTP	✓
MPEG-TS	✓
Apple HLS	✓
MPEG-DASH	✓
Adobe HDS	✓
Microsoft Smooth Streaming	✓
WebRTC(Preview)	✓

H.264: What's it Cost You? - Royalties

- Hardware manufacturers
  - MPEG LA - Royalties for hardware (US $0.20/unit - US $9.75 million cap)
  - Motorola - Sued Microsoft and won, but tiny royalty (US $0.00555/unit)
  - Nokia - sued Apple and settled
- Content publishers
  - Subscription (not limited by title)
    100,000 or fewer subscribers/yr = no royalty;
    100,000 to 250,000 subscribers/yr = $25,000;
    250,000 to 500,000 subscribers/yr = $50,000;
    500,000 to 1M subscribers/yr = $75,000;
    1M subscribers/yr = $100,000
  - Title-by-Title - 12 minutes or less = no royalty;
    12 minutes in length = lower of (a) 2% or (b) $0.02 per title •

H.264: What's it Cost You?

- Storage/bandwidth
  - According to Netflix: x265 and VP9 up to 50% more efficient, especially at higher resolutions. http://bit.ly/nf_codec
  - So: supporting either VP9, HEVC, or both will shave some bandwidth costs
- Capacity - if delivering over fixed capacity infrastructures
- QoE – mobile (more later)
  - 1 mbps stream - H.264 - 360p - 76.19 VMAF score
  - 1 mbps stream HEVC/VP9 - up to 720p - 85.84 VMAF score (noticeably higher quality)
- QoE - In the living room

QoE in the Home

- Netflix ISP Speed Index - Sweden
  - Prime time Netflix performance on particular ISPs
- At 3.6 mbps
  - H.264 is 720p (94.30 VMAF)
  - HEVC is 1080p (96.63 VMAF)
  - Not a huge deal, but noticeable to some, particularly on very large screen TVs

ISP LEADERBOARD - OCTOBER 2017

RANK	ISP	SPEED Mbps	PREVIOUS Mbps
1	Com Hem	3.94	4.00
2	Bredbandsbolaget (Telenor)	3.92	3.96
3	Ownit	3.90	3.94
4	Bahnhof	3.88	3.90
5	T3	3.85	3.84
6	AllTele	3.82	3.81
7	Bredband2	3.81	3.80
8	Telia	3.77	3.83
9	TDC	3.16	3.29
10	Tele2	3.08	3.15

H.264: The Big Question

- How much longer will you be encoding H.264?

H.264: The Big Question

- How much longer will you be encoding H.264?
  - Forever

HEVC

- What’s it give you?
- What’s it cost you?
- The big question: When should you start to support HEVC for HLS?

HEVC: What's it Give You?

- Compatibility

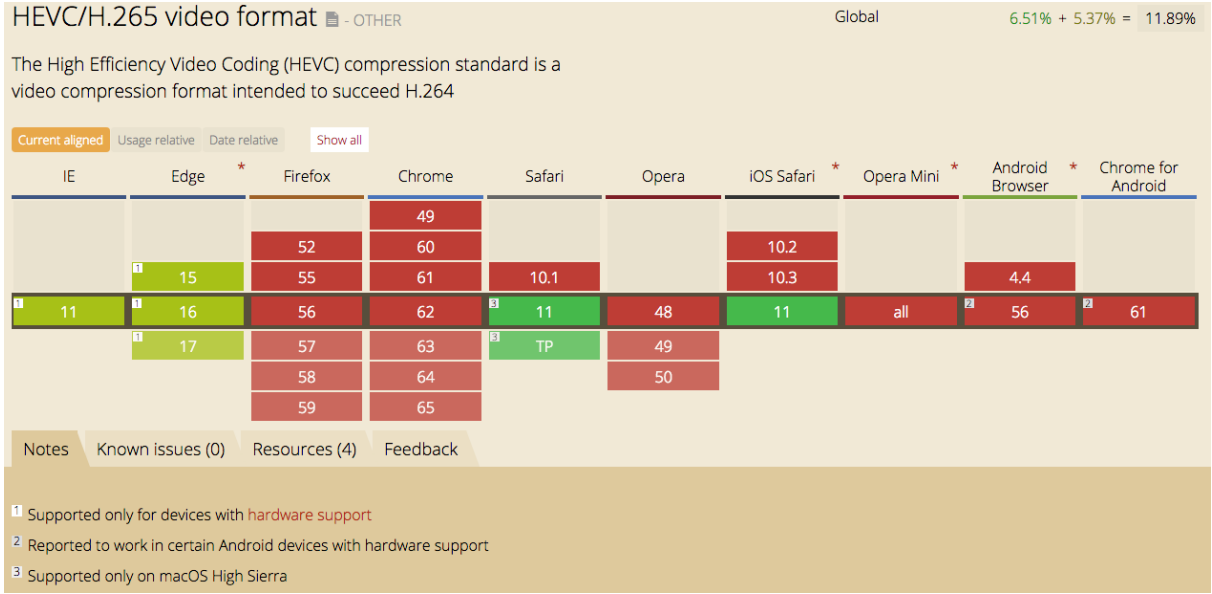
HEVC Browser and Mobile (www.caniuse.com)

Supported Platforms

- Windows 10
  - Computers with HEVC hardware decode
  - Not HLS
- MacOS - High Sierra
- iOS - 11
- Android - 5.0 + (not HLS)

No support

- Computer - Chrome and Firefox
- Pre MacOS/iOS 11
- Pre-Windows 10



HEVC Compatibility Matrix

OTT	**H.264**	**HEVC**
Roku	Yes	4K capable
Chromecast	Yes	Ultra
FireTV	Yes	2nd Gen
Apple TV	Yes	4K
Smart TV		
Samsung	Yes	**2015+**
HbbTV	Yes	**Yes**
Smart TV Alliance	Yes	**Yes**

HEVC:Live Transcoding - Available for Key Formats

This is Wowza; Nimble Streamer as well.

Video Output	H.265
Adobe RTMP	✔
RTSP/RTP	✔
MPEG-TS	✔
Apple HLS	✔
MPEG-DASH	✔
Adobe HDS	
Microsoft Smooth Streaming	
WebRTC(Preview)	

HEVC: What's it Give You?

- Simple distribution via HLS, plus other compatible platforms
- Live transcoding
- Some bandwidth savings over H.264
- Improved QoE (particularly mobile)
- 4K content

HEVC: What's it Cost You?

- Huge royalties for decode
  - MPEG LA - $25 million annual cap
  - HEVC Advance - $40 million annual cap
  - Velos Media – unknown
  - Nokia/Technicolor – unknown
  - Very significant in emerging markets where low cost devices prevail
- Royalties for subscription and pay-per-view
  - HEVC Advance $5 million annual cap
- Storage costs at origin server ~ 65% of H.264

HEVC: The Big Question: When to Support HEVC in HLS?

1. Breakeven analysis

- Cost - Encoding cost + storage cost + player development cost
  - Player cost – minimal – Apple does this for you
- Divide by bandwidth savings per hour to compute breakeven, but what are bandwidth savings?
  - Not as high as enabled bitrate reduction
  - **So, just because HEVC enables same quality as H.264 at 50% of data rate doesn't mean you save 50% of bandwidth**

How ABR Works

- Netflix is at 4 Mbps
- Assume you’re at 4.5 Mbps

	H.264	HEVC
Data Rate	Rez	Rez
145	234p	432p
365	270p	540p
730	360p	720p
1100	432p	720p
2000	540p	1080p
3000	720p	1080p
4500	720p	1080p *
6000	1080p	1080p *
7800	1080p	1080p *

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  - HEVC would be this stream

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How ABR Works

- Netflix is at 4 Mbps
- Assume you’re at 4.5 Mbps
  - H.264 would be this stream
  - HEVC would be this stream
- No bitrate saving at 4.5 Mbps

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- Netflix is at 4 Mbps
- Assume you’re at 4.5 Mbps
  - H.264 would be this stream
  - HEVC would be this stream
- No bitrate saving at 4.5 Mbps
- Some for higher bitrates

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How ABR Works

- Netflix is at 4 Mbps
- Assume you're at 4.5 Mbps
  - H.264 would be this stream
  - HEVC would be this stream
- No bitrate saving at 4.5 Mbps
- Some for higher bitrates
- Clearly – just because HEVC cuts bitrates by 50% doesn't mean you cut bandwidth costs by 50%

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Data Rate	Rez	Rez
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4500	720p	1080p *
6000	1080p	1080p *
7800	1080p	1080p *

HEVC: The Big Question: When to Support HEVC in HLS?

2. The big benefit is QoE

- Higher quality video at each rung of the encoding ladder
  - Improved significantly for mobile connections
- VMAF delta of 6 points equals a just noticeable difference where 75% of viewers notice the difference

	H.264		HEVC		
Data Rate	Rez	VMAF	Rez	VMAF	Delta
145	234p	21.50	432p	26.56	5.06
365	270p	52.52	540p	65.12	12.61
730	360p	69.10	720p	78.45	9.34
1100	432p	80.61	720p	87.32	6.72
2000	540p	88.02	1080p	92.94	4.92
3000	720p	92.89	1080p	95.86	2.97
4500	720p	95.06	1080p *	97.53	2.47
6000	1080p	96.99	1080p *	97.41	0.41
7800	1080p	97.71	1080p *	97.53	-0.18

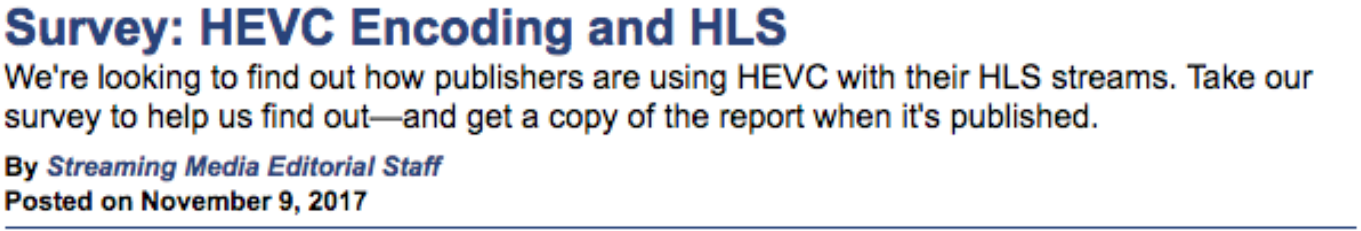
3. HEVC Decode – Probably Not an Issue

● Streaming Media Article – HEVC in HLS: How Does it Effect Performance (http://bit.ly/HEVC_HLS_CPU)

- iPhone 6 – 15% higher CPU than H.264
- iPhone 7 – Same CPU as H.264 (figure)
- 2010 iMac – about the same
- 2014 MacBook Pro – About 7% higher CPU for HEVC
- 2011 MacBook Air – About the same

- Bottom line: Won't be an issue for most compatible devices

HEVC: The Big Question: When to Support HEVC in HLS?



Survey: HEVC Encoding and HLS

We're looking to find out how publishers are using HEVC with their HLS streams. Take our survey to help us find out—and get a copy of the report when it's published.

By *Streaming Media Editorial Staff*

Posted on November 9, 2017

4. When will your competitors support HEVC/HLS?

- Survey still open - http://bit.ly/hls_hevc_survey
- So far, about 60% of respondents predict supporting HEVC in HLS by the end of 2018

Google VP9

- What's it give you?
- What's it cost you?
- The big question: When should you encode to VP9 for browser and/or Android delivery?

VP9: What's it Give You?

- Compatibility

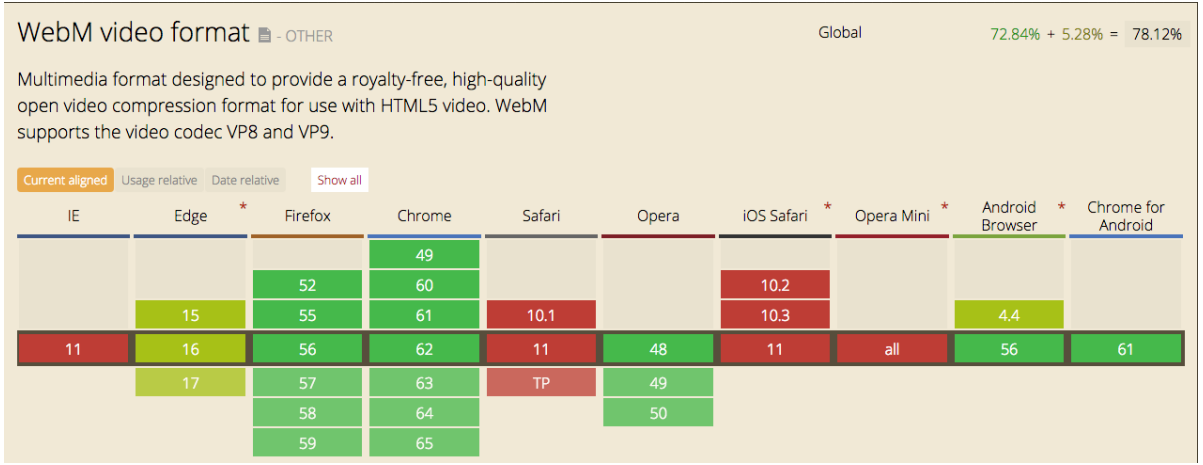
VP9 Browser and Mobile (www.caniuse.com)

Supported Platforms

- Windows
  - All but IE
- Android - 4.2 +

No support

- Mac Safari
- iOS
- IE (which means lots of pre-Windows 10)



VP9 Compatibility Matrix

OTT	**H.264**	**HEVC**	**VP9**
Roku	Yes	4K capable	4K capable
Chromecast	Yes	Ultra	Ultra
FireTV	Yes	2nd Gen	2nd Gen
Apple TV	Yes	4K	**No**
Smart TV			
Samsung	Yes	**2015+**	2015+
HbbTV	Yes	**Yes**	**No**
Smart TV Alliance	Yes	**Yes**	**No**

VP9:Live Transcoding - Available for DASH

This is Wowza; Nimble Streamer as well.

Video Output	H.263	VP9
Adobe RTMP		
RTSP/RTP		
MPEG-TS		
Apple HLS		
MPEG-DASH		✔
Adobe HDS		
Microsoft Smooth Streaming		
WebRTC(Preview)		✔

VP9: What's it Give You?

- Great access to browsers in computers
- Great access to Android (important in many emerging economies)
- Some access to OTT/Smart TVs
- Some bandwidth savings over H.264
- Improved QoE (particularly mobile)
- 4K content

VP9: What's it Cost You?

- Royalty free, but no indemnifications from Google
  - Google insists that they performed full IP review before buying ON2 and had been careful not to infringe since
- Velos Media - "As it relates to royalties, we know that VP9 incorporates patented technologies, including some of the patents being licensed by Velos Media for HEVC" (http://velosmedia.com/technology/q-and-a/)
  - Sowing Fear, Uncertainty, and Doubt (FUD) or a shot across the bow?
  - Hard to assume that Google didn't do their due diligence when buying On2 and during subsequent development of VP9
- Same storage costs at origin as HEVC

VP9: The Big Question: When to Support VP9 in the Browser and/or Android?

- Break even analysis – same analysis as HEVC except development costs will be higher
  - Will have to supply detection and fallback logic supplied by Apple
  - Some bandwidth saving, but not equal to file size reduction

VP9: The Big Question: When to Support VP9 in the Browser?

2. QoE analysis; similar to HEVC

- Higher quality video at each rung of the encoding ladder
    - Improved significantly for mobile connections

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Data Rate	Rez	VMAF	Rez	VMAF	Delta
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VP9: The Big Question: When to Support VP9 in the Browser?

2. QoE analysis; similar to HEVC

- Higher quality video at each rung of the encoding ladder
  - Improved significantly for mobile connections
- Very important in price sensitive emerging markets where bandwidths are very low and iPhones uncommon

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VP9: The Big Question: When to Support VP9 in the Browser?

2. QoE analysis; similar to HEVC

- Higher quality video at each rung of the encoding ladder
  - Improved significantly for mobile connections
- Very important in price sensitive emerging markets where bandwidths are very low and iPhones uncommon
  - **Could be technology enabler for low cost services**
  - **All Netflix mobile downloads are VP9 as are most mobile streaming efforts**

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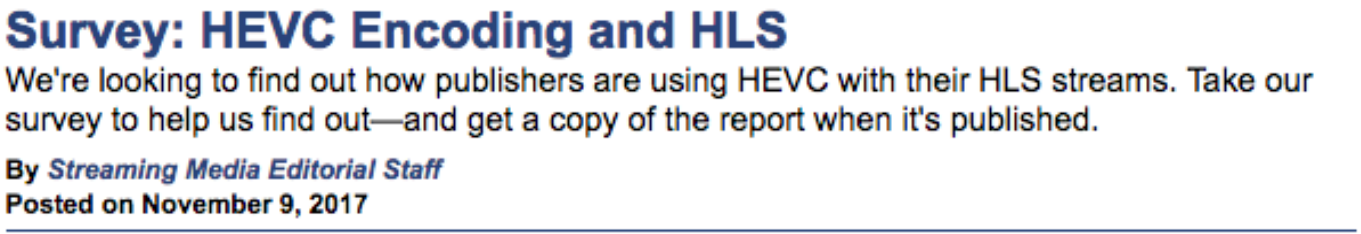
VP9: The Big Question: When to Support VP9 in the Browser?



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By *Streaming Media Editorial Staff*
Posted on November 9, 2017

3. When will your competitors support VP9?

- Survey still open - http://bit.ly/hls_hevc_survey
- So far, about 26% of respondents predict supporting VP9 in 2017 and beyond

Alliance for Open Media AV1

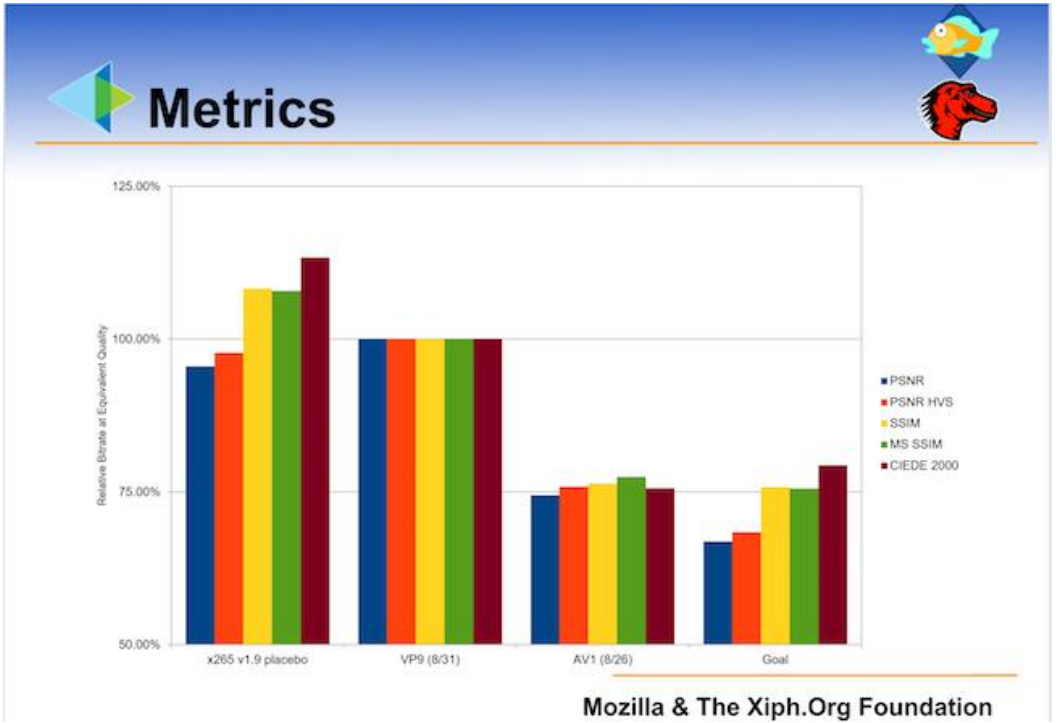
- What’s it give you?
- What’s it cost you?
- The big question: When relevant to non-members?

What is AV1?

- Codec produced by the Alliance for Open Media (AOM)
- Prominent members include:
  - Codec vendors – Google, Microsoft, Mozilla, Cisco
  - Hardware – Intel, NVIDIA, ARM, Broadcom, Ittiam
  - Content – YouTube, Netflix, Amazon, Facebook, Hulu, BBC
  - Infrastructure – Bitmovin, Ateme, IBM
  - Technically sophisticated group (hold that thought)

AV1: What's it Give You?

- Same quality as x265 (placebo) at less than 75% of the bandwidth



Current Unknowns

- Code freeze date (was 12/2017) – will hear today
- Encoding speed
- Output quality beyond Mozilla estimates
- Decode requirements (mobile, desktop)

AV1: What's it Cost You?

- Royalty free, but no indemnifications from Google
- Velos Media - "And, while AV1 has not yet been publicly released, it may also incorporate patented technology from many parties." (http://velosmedia.com/technology/q-and-a/)
  - Sowing Fear, Uncertainty, and Doubt (FUD) or a shot across the bow?
  - Can we assume that Alliance Members are naïve regarding technology IP?

AV1: The Big Question: When Relevant to Non-Members?

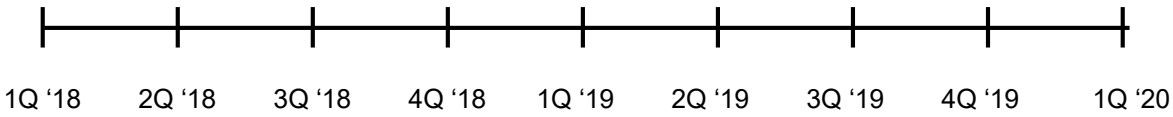
- Value proposition
  - 20 - 30% bitrate savings over HEVC/VP9 (unproven)
  - Currently ~ 400x VP9 encoding time, before optimization
    - Encoding time will decrease, but it’s got a long way to go to become usable, much less competitive
- Initial sweet spot will be:
  - Exceptionally high-volume content (Netflix)
  - YouTube for very high profile content

Also: Not a Short Term Solution for Live

- Don’t expect to see AV1 here anytime soon
- Possible in cloud environment, but will need many more cores than other codecs

Video Output	H.265	H.264	H.263	VP9
Adobe RTMP	✓	✓		
RTSP/RTP	✓	✓	✓	
MPEG-TS	✓	✓	✓	
Apple HLS	✓	✓		
MPEG-DASH	✓	✓		✓
Adobe HDS		✓		
Microsoft Smooth Streaming		✓		
WebRTC(Preview)		✓		✓

Decode/Usage Rollout (My Best Guess)



Browser
- Chrome
- Firefox
- Edge
- Safari

? (still no VP9)

Mobile
- iOS
- Android

? (still no VP9)

Content

(YouTube)

(Netflix)

Amazon?
Facebook?
Microsoft?

OTT/Smart TVs

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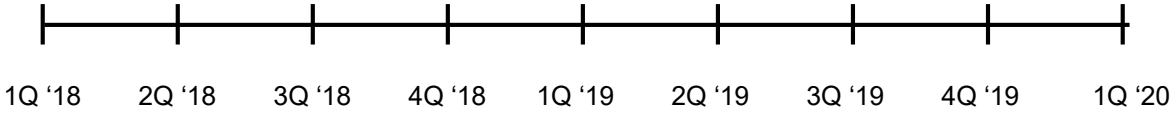

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Content

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(Netflix)

Amazon?
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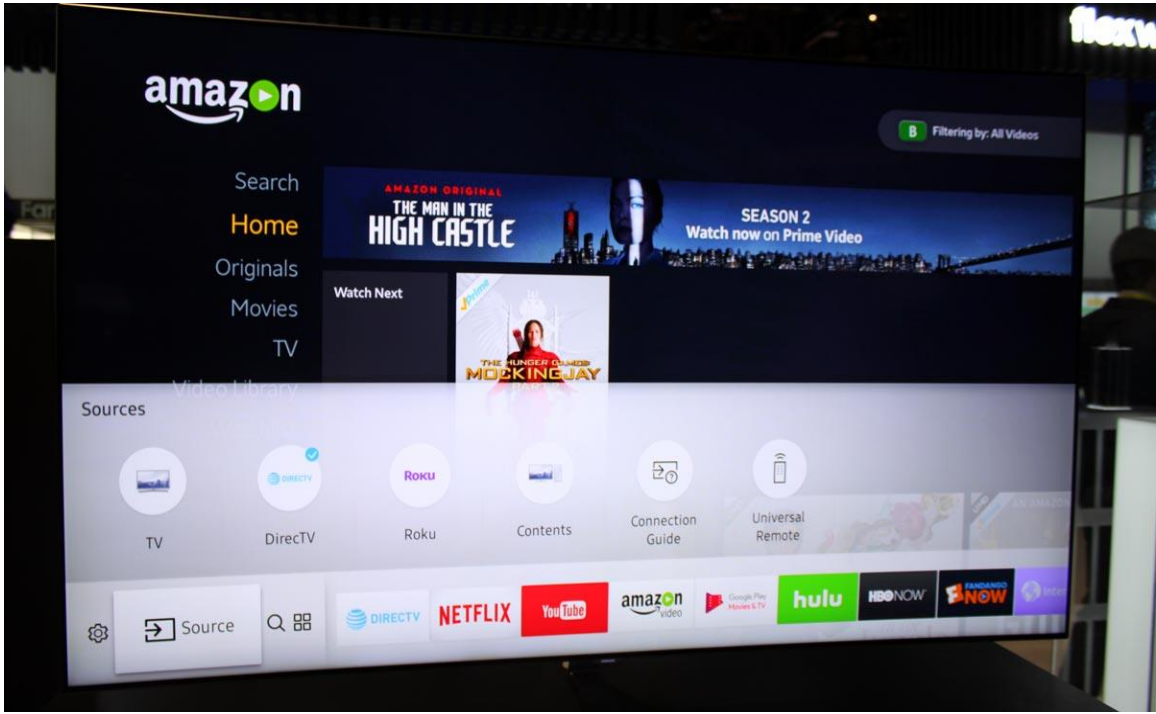
OTT/Smart TVs

Bottom Line:

-- If you’re not one of the companies on the front panel of most smart TVs

- AV1 won’t be relevant through the end of 2018 or later



Counterpoint:

- 34% of Streaming Media survey respondents are considering adding AV1 in 2017 or beyond
  - Numbers subject to change
  - Please take the survey! http://bit.ly/hls_hevc_survey

V-Nova PERSEUS

- What’s it give you?
- What’s it cost you?
- The big question: who should care about PERSEUS in 2018 and beyond?

PERSEUS: What's it Give You?

- Ability to upgrade existing H.264 set top boxes to higher quality HD formats
  - Sky Italia
- Very good low bitrate quality and low CPU usage
  - Fastfilmz - Android service in India
- Now available in browser with OpenTelly player
  - Apps for iOS and Android

PERSEUS: What's it Cost You?

- Fee based usage
- Deal-by-deal basis

PERSEUS: Who Should Be Considering

- OTT companies with older STBs on the market; want to cut bandwidth costs
- Those seeking ultra-low bitrate quality, most likely in emerging markets

Divideon xvc

- Talk coming later
- Bottom line – HEVC quality with known royalty costs

Questions