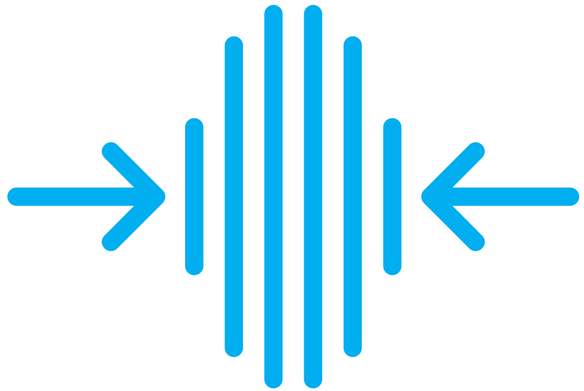
Media Tech Intelligence Briefing:

Codecs: Market Overview

May 2022



Developments in Codecs

Forces driving the codecs industry

Popularization of streaming, cloud gaming and virtual experiences

The explosive growth of data volumes is pushing content providers to find new ways to reduce high effective bandwidth and related costs by improving compression efficiency.

Fragmentation of viewing and devices

Consumers are increasingly viewing content on multiple devices and purchasing 4K/UHD TV sets and gaming consoles (the prices of which continue to fall), allowing better virtual, immersive experiences.

Move to live streaming of 4K/UHD content

Media industry's permanent move to live video streaming of 4K/UHD content increased the adoption of the HEVC codec during the pandemic, as broadcasters switched to decentralized and remote production models.

Move to the cloud and IP networking

Broadcasters' move to IP- and cloud-based workflows is speeding up the adoption of new codecs, enabling them to stream 4K/UHD content at a manageable bitrate over the cloud and IP.

Sources: IABM

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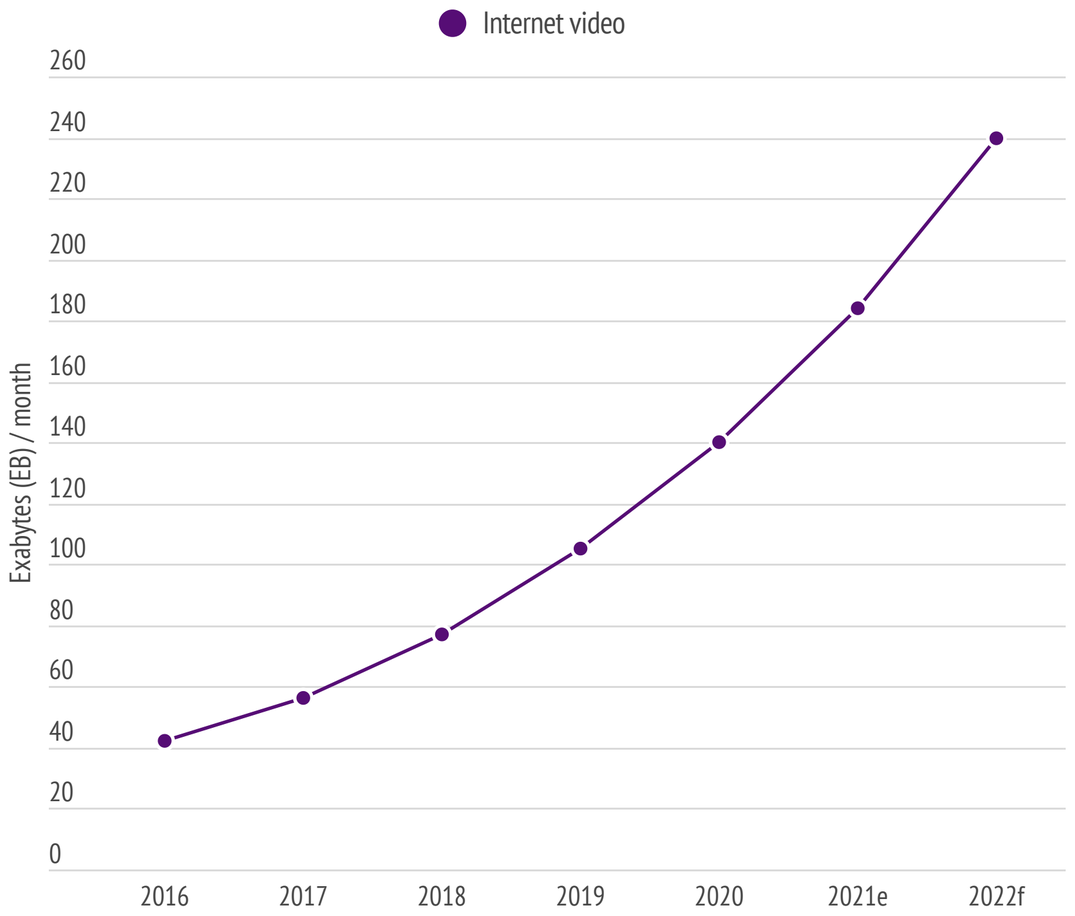
Battle for bandwidth savings and a better UX

The content-led streaming boom caused by the COVID-19 pandemic resulted in a massive peak in internet data traffic globally, making media businesses chase bandwidth savings, while investing in compression technologies to better compete in new market segments like connected TVs (CTVs) with HDR and to respond to the growing demand for device-optimized interactive, virtual experiences augmenting the overall UX. Investments in new codes enable media businesses to better target individual viewers and guarantee a customized UX with low latency. For example, the HEVC codec is increasingly used to target living rooms or mobile viewers with premium 4K UHD content, whereas AV1 is quickly replacing VP9 in browser-based playback viewing.

Internet Video Traffic Globally



Sources: IABM, Cisco Systems, vicuesoft.com

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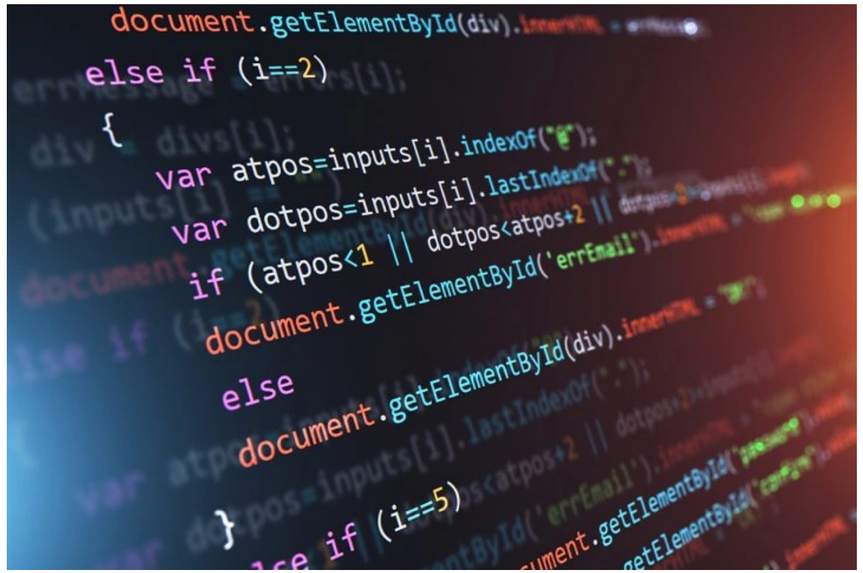
Fragmentation of the codecs market

Today, a major challenge for the adoption of new codecs is that the market remains very fragmented and currently there are no signs that one or two codecs will become the mainstream or standardized technology for the whole industry. The fragmentation stems from a range of factors: many tech companies are lobbying their own technologies and standards, some governments (e.g., in China) are imposing the use of specific codecs to prevent political risks, while many hardware-based companies like IPTV providers prefer to stick to older technologies like AVC on which they already spent lots of money in the past. All this is causing market inertia and causing different codecs to be developed and used in silos. Also, there is general confusion in the market about the pricing of some new codecs - some codecs are free, while others are subject to a complex set of royalty fees.



Sources: IABM, vicuesoft.com, wowza.com, Movavi

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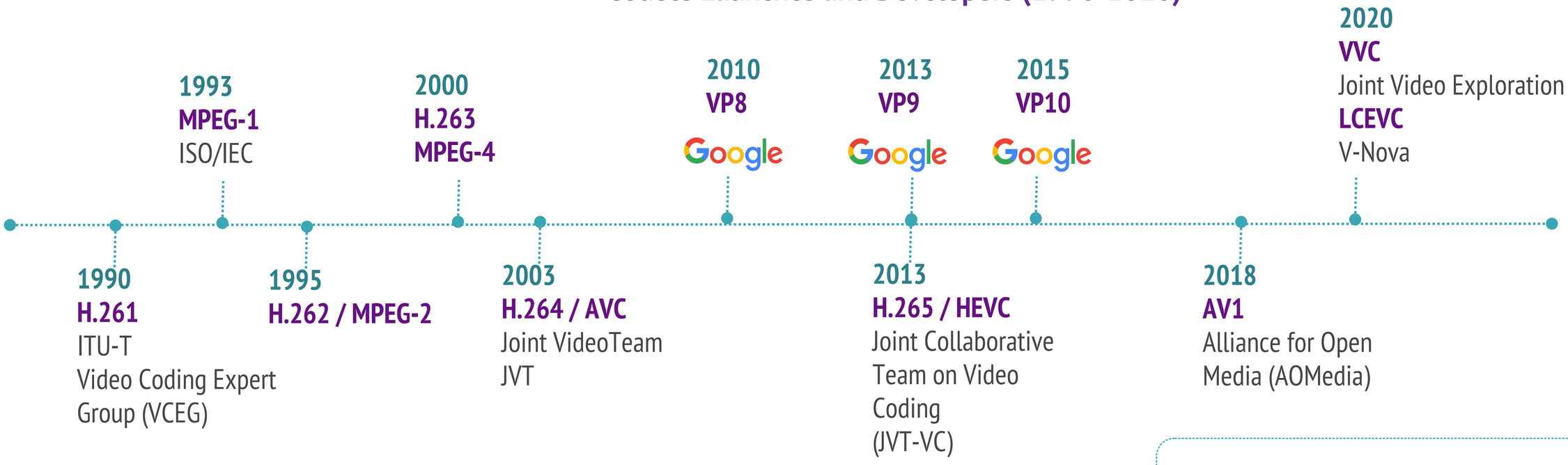
Fragmentation of the codecs market

Codecs Launches and Developers (1990-2020)



The Alliance for Open Media (AOMedia) was established in 2015 by big technology companies to develop an open source and royalty-free video codec AV1, challenging the dominance of H.265/HEVC codec, which had turned out to be very complex in terms of royalty structure and licensing.

IBM, aws, NETFLIX, Google, intel, SAMSUNG, mozilla Firefox, BITMOVIN, CISCO

Sources: IABM, ResearchGate, flatpanelshd.com

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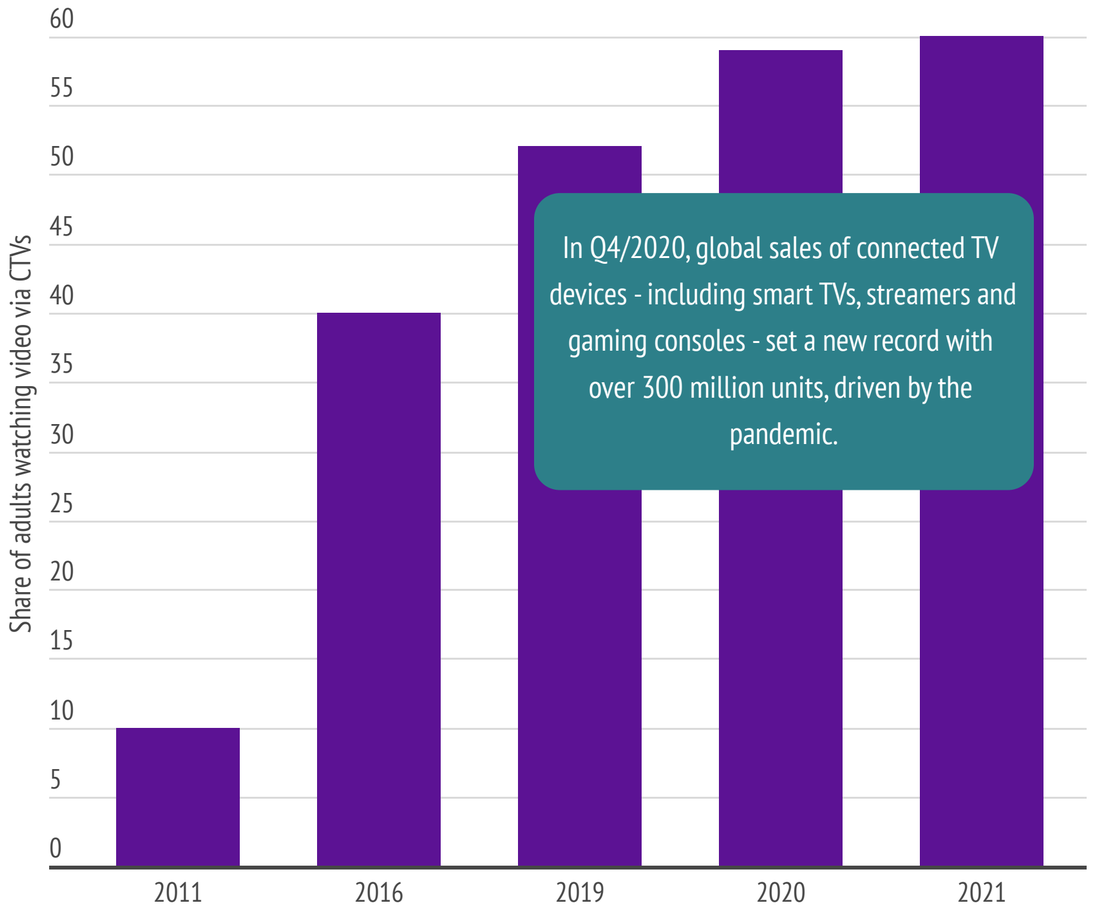
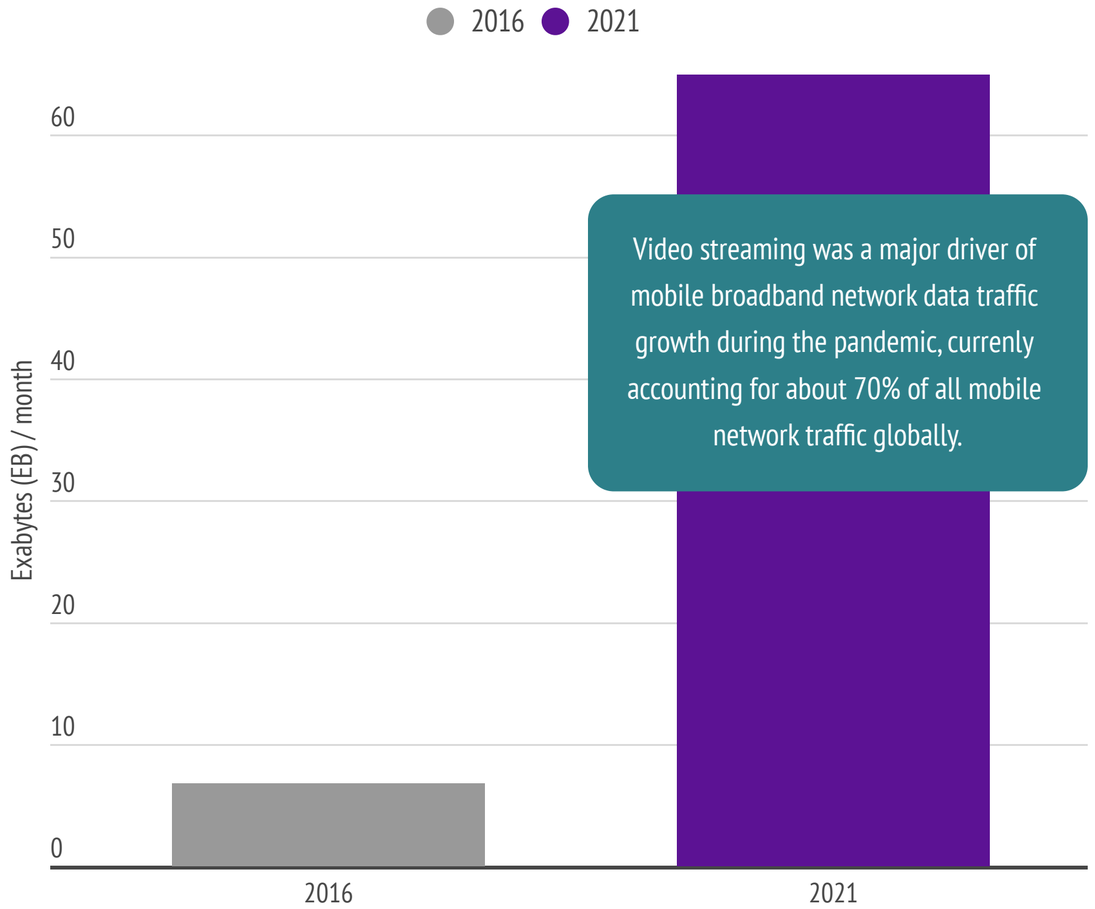
Fragmentation of viewing devices

Connected TV Penetration in the US*



Total Mobile Traffic Globally



Sources: IABM, Leichtman Research Group, Strategy Analytics, Ericsson Mobility Report 2021. *Note: Share of adults watching video via a connected TV device weekly in the US

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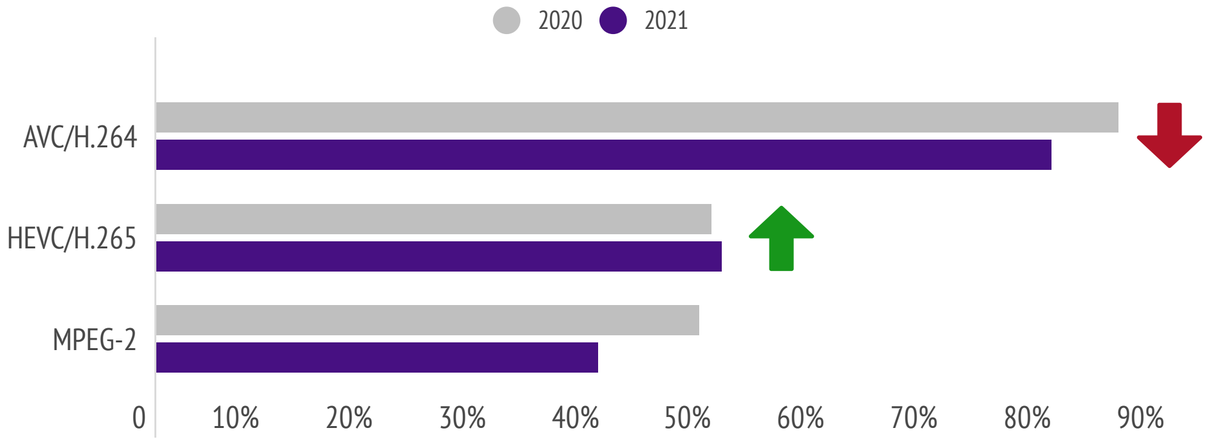
Move to live streaming of 4K/UHD content

COVID-19 Impact on Codecs for Live Content:

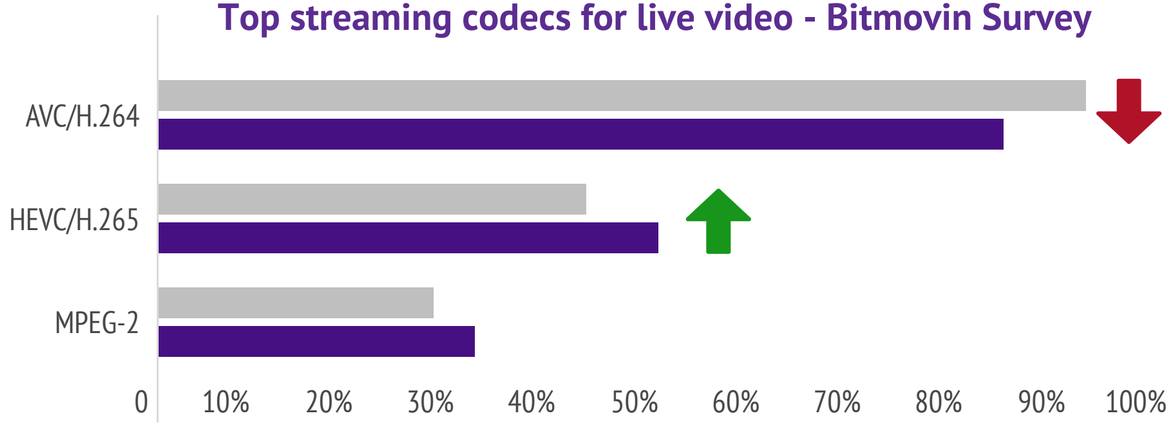
The accelerated transition to DTC in 2021 sped up cloud-based deployments and the adoption of IP networking, allowing media companies to do and control live production remotely as well as stream live content with low latency. As a result, demand for the HEVC is increasing, because it enables broadcasters to stream 4K/UHD content at a manageable bitrate over the cloud and IP.

However, as IP-based technologies for production continue to mature, standards like ST 2110 - designed for live studio production - will grow in popularity, as they support compressed, lossless codecs like JPEG-XS, which enable streaming 8K over IP. The emergence of game engines, VFX and virtual studios within mainstream production, as well as increasing demand for interactivity, mean that the network infrastructure needs high bandwidth to handle uncompressed 4K and 8K, boosting demand for ST 2110.

Top streaming codecs for live video - Haivision Survey



Top streaming codecs for live video - Bitmovin Survey



Sources: IABM, Haivision, Bitmovin, SMPTE, tvtechnology.com

Developments in Codecs

Move to live streaming of 4K/UHD content

Trend 1: Move to immersive and new resolutions

Codec suitability	Live origination	Live transcode	Low latency	4K	HDR	8K
AVC/H.264	Excellent	Excellent	Excellent	Poor	Poor	Poor
HEVC/H.265	Good	Good	Nascent	Excellent	Excellent	Good
AV1	Nascent	Nascent	WebRTC	Excellent	Nascent	Good

Trend 2: Fragmentation of viewing devices

Codec compatibility	Browser	Mobile	Connected TV / OTT
AVC/H.264	Virtually all	All	All
HEVC/H.265	Very little	Android, iOS	All
AV1	Edge, Chrome, Firefox, Opera	Android	Nascent

Sources: IABM, Haivision, Bitmovin

Big streaming players are driving demand for 4K content, while in linear broadcasting the move to IP infrastructure will accelerate the adoption of 4K/UHD in the next few years. As content providers continue to increasingly invest in interactivity - particularly in sports - they will need higher-efficiency codecs to allow viewers not only to enjoy immersive and interactive features, but also to enable a smooth UX on any device.

> *If you're looking for higher resolutions, higher refresh rates, higher bitrate content, and higher quality content (such as HDR), and all of those technologies in your codec is key to actually making that happen on your devices. This is where HEVC, AV1, and the gaining interest in VVC is coming into play.*
>
> ***Christian Feldmann, Team Lead Encoding, Bitmovin***

Sources: IABM, wowza.com, IBC365, Bitmovin

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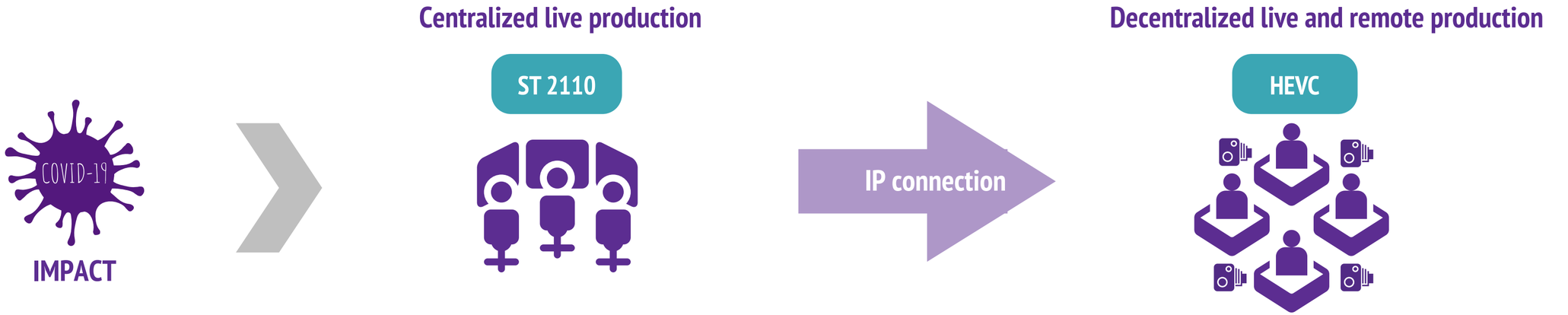
Move to live streaming of 4K/UHD content - Role of ST 2110



SMPTE ST 2110

The COVID-19 pandemic dramatically reduced live studio-based productions - for which SMPTE ST 2110 was principally designed - and decreased investment in live infrastructure overall with a new focus on remote live and remote scripted infrastructure, making ST 2110 less appealing

Broadcasters' move to remote collaboration and decentralized productions increased the adoption of the HEVC codec, reflecting the industry's permanent shift toward live video streaming of 4K UHD content. ST 2110 cannot be used over the internet, because its' multicast technology requires IP networks capable of supporting a minimum of 10Gbps of bandwidth

> *It is not really that 2110 is the wrong standard, it's that the means of content consumption has started to change rapidly [toward remote live production]. The global pandemic accelerated this when live sports and stage events, all the stuff that **2110** is **dedicated** to, almost **vanished** overnight. **Investment** in a lot of production is **not hitting the 2110 nail** on the head at the moment.*
>
> ***Bruce Devlin, VP of Standards, SMPTE & Chief Media Scientist, Dalet Digital Media Systems***

Sources: IABM, SMPTE, IBC365, Haivision, tvtechnology.com

Developments in Codecs

Move to live streaming of 4K/UHD content - Internet-ready protocols

Media companies' shift to remote production and live streaming during the pandemic boosted the use of "internet-ready", video over public IP protocols like SRT (Secure Reliable Transport) and RIST (Reliable Internet Stream Transport), which are designed for low latency contribution over IP and the public internet. This significantly reduces networking costs, because these protocols are specifically designed for internet delivery and to provide low latency over variable performance networks - enabling higher quality of live and remote production. The adoption of SRT and RIST thus means extra investment in encoders.

Protocols like SRT and RIST offer live OTT productions cost savings by simplifying and reducing the data load without impacting the image quality. Simultaneously, both protocols allow a high-quality codec (like HEVC, VVC, AV1) to be used for production - this is important because video quality is maintained throughout the supply chain when re-encoded and re-transcoded for the delivery to consumer devices. As media companies continue to invest in immersive and interactive content, low latency streaming applications and solutions will be in high demand, particularly for gaming, betting, online video games and second-screen experiences.

ALJAZEERA SRT SECURE RELIABLE TRANSPORT

Remote production: Al Jazeera is already using SRT for low-latency content acquisition and distribution globally. After having adopted the SRT protocol, the broadcaster can transport breaking news from the field to remote studios for syndication - this reduces costs and technical issues related to satellite and MPLS networks.

ESPN SRT SECURE RELIABLE TRANSPORT

Live sports: ESPN currently uses SRT to broadcast live sports events from universities across the US, which has eliminated its need for satellite uplinks and thus has reduced costs significantly - SRT has enabled ESPN to "do more with less". In addition, by using SRT ESPN can offer games and other interactive content on its national platform.

Sources: IABM, wowza.com, RIST Forum

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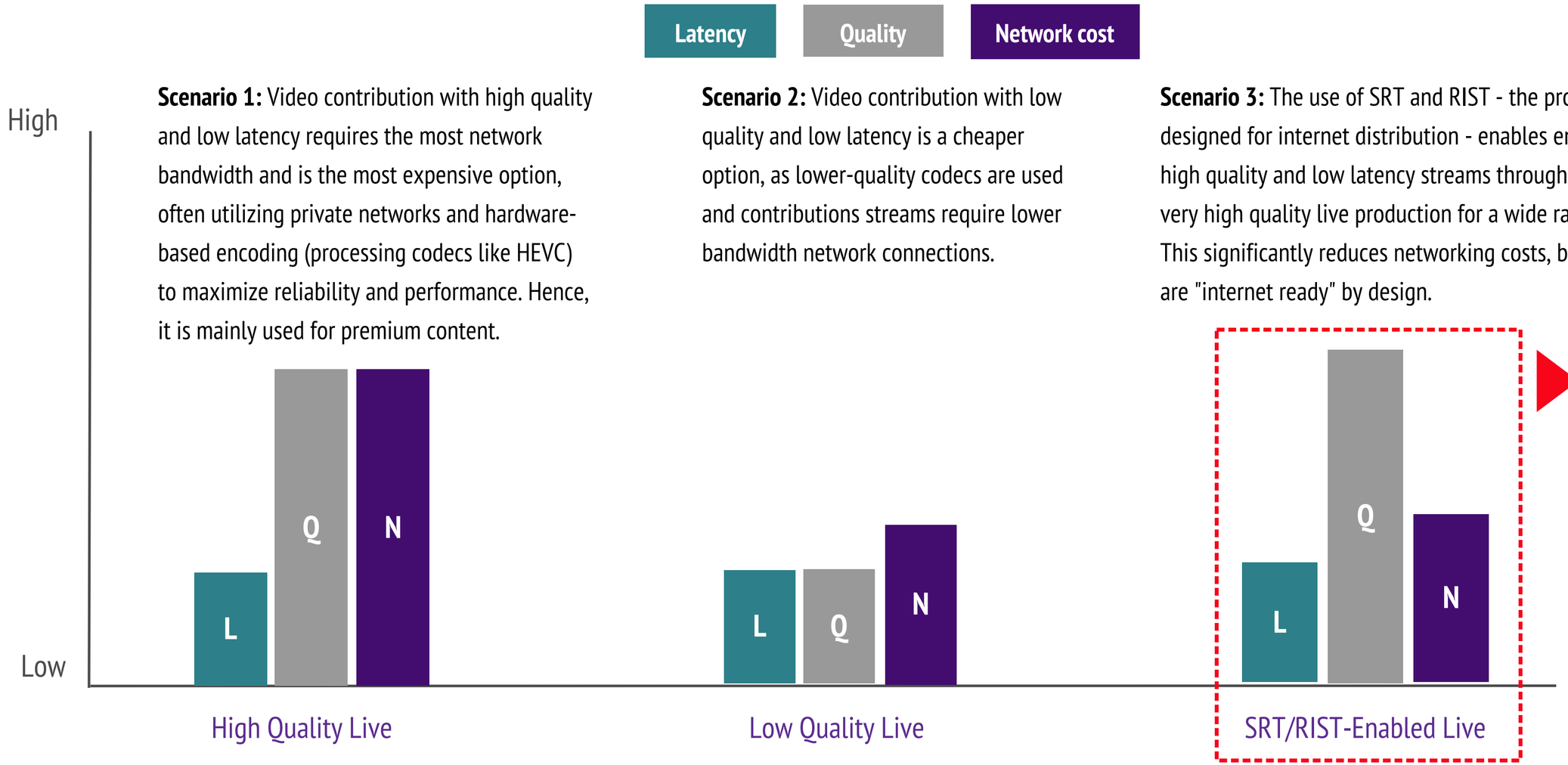
Move to live streaming of 4K/UHD content - Internet-ready protocols

Live contribution encoding - Performance-cost trade-off



Scenario 1: Video contribution with high quality and low latency requires the most network bandwidth and is the most expensive option, often utilizing private networks and hardware-based encoding (processing codecs like HEVC) to maximize reliability and performance. Hence, it is mainly used for premium content.

Scenario 2: Video contribution with low quality and low latency is a cheaper option, as lower-quality codecs are used and contributions streams require lower bandwidth network connections.

Scenario 3: The use of SRT and RIST - the protocols specifically designed for internet distribution - enables encoders to deliver high quality and low latency streams through the internet, enabling very high quality live production for a wide range of new venues. This significantly reduces networking costs, because SRT and RIST are "internet ready" by design.

HEVC, VVC and AV1 used in production, maintaining video quality throughout the supply chain.

Sources: IABM, thebroadcastbridge.com, tvbeurope.com, RIST Forum, OBS Studio

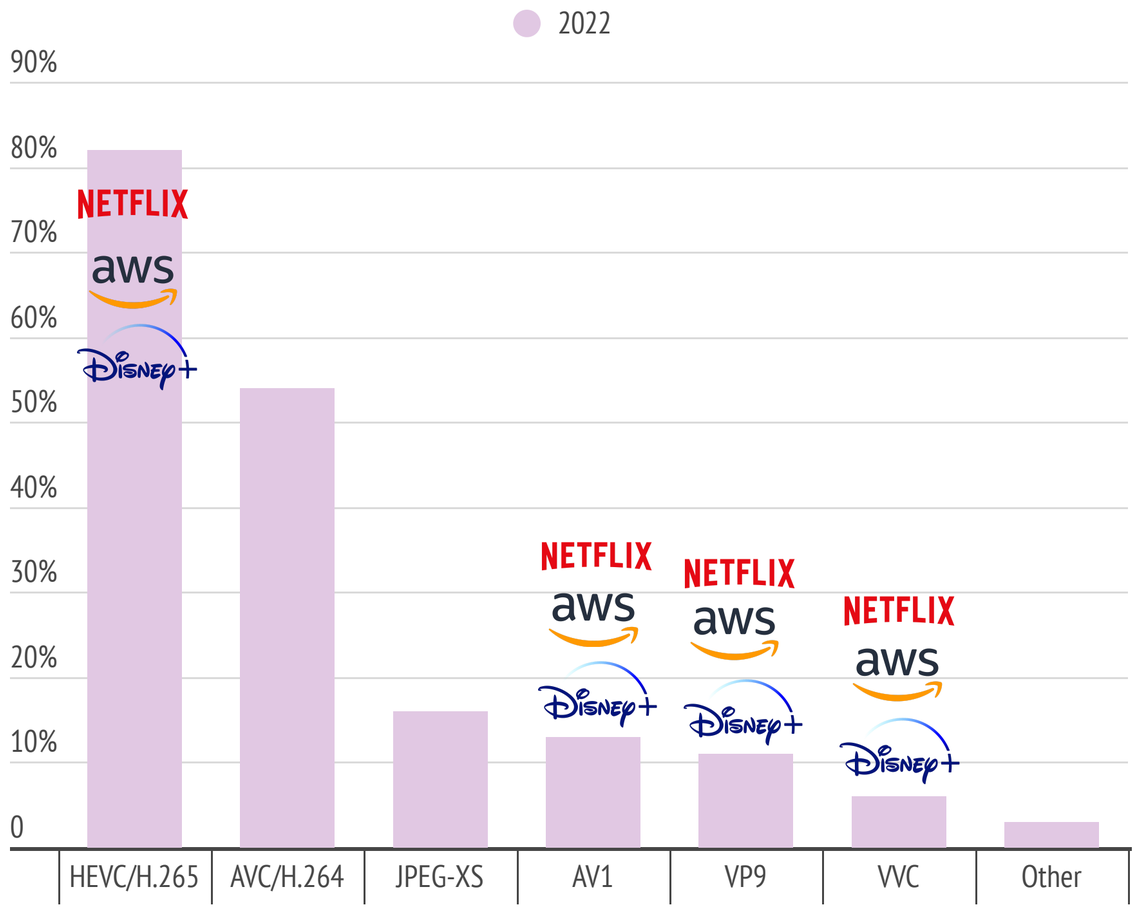
Developments in Codecs

Move to (live) streaming of 4K/UHD content

The content-led streaming boom caused by the COVID-19 pandemic accelerated media companies' investments in premium 4K/UHD content and low-latency, high quality live streaming technology, boosting the adoption of high-efficiency encoders and the latest video compression technology like HEVC (H.265), AV1 and VVC (H.266) video codecs.

The trend toward the adoption of AV1, VP9 and VVC is driven by big streaming services like Netflix, Amazon, Disney+ and Apple TV+ (which are currently using HEVC to stream 4K HDR content), because AV1 was developed by the Alliance for Open Media, including Amazon, Netflix, Microsoft, IBM, Google, Facebook, Intel and Mozilla as members. Netflix has announced that it will "roll out AV1 on all our platforms", while Google-owned YouTube is already requiring AV1 for 8K video.

Forecast: Top video streaming codecs in 2022 - Haivision Survey



Sources: IABM, Haivision, Netflix, Google

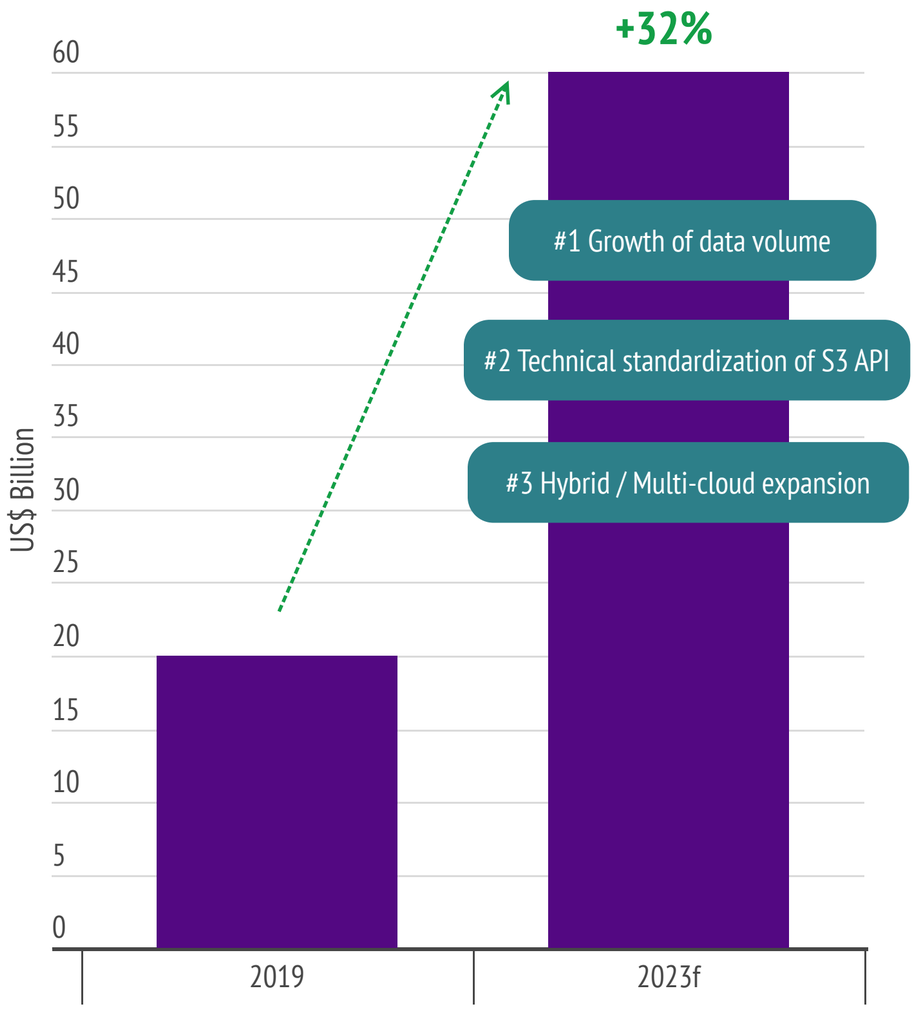
Developments in Codecs

Move to to the cloud and IP networking

The COVID-19 pandemic significantly accelerated broadcasters' move to the cloud and cloud storage - enabling greater flexibility, scalability, accessibility and cost-efficiency - when the need for collaborative and remote work peaked dramatically. In the long term, major drivers for cloud storage adoption include the gradual cost reduction of both the actual storage itself and the bandwidth required to use it.

Using cloud storage also gives greater flexibility for viewers to choose when and how they want to watch content and whether want to record and store it, improving UX. This can be seen in how library storage and time-shifting consumption traffic have increased among broadcasters. Also, viewers' increasing demand for 4K/UHD, HDR and immersive VR/AR content means that more digital content compression (e.g., HEVC, AV1) will be needed, favoring cloud storage.

Cloud Storage Services Revenue Globally



Sources: IABM, IBC365, IDC, Cloudian

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Pricing - From complex royalty fees to free codecs

While licencing and untransparent royalty payments have hindered the adoption of HEVC, the open-source codecs - AV1 developed by the Alliance of Open Media and VP9 released by Google - are royalty-free providing financial incentives in addition to requiring less bandwidth, taking less storage space and making encoding faster. For the viewer, this means faster start times and smoother playback without compromising high image quality whether they are live streaming or using VOD services - improving UX. However, the new royalty-free codecs are not necessarily the cheapest; the additional complexity that new codecs introduce translates to increased encoding costs. This is especially the case for large-scale content providers like YouTube, which need to use more advanced codecs to reduce streaming costs.

Pricing

Video codec	Release year	Royalties	Developer
AVC/H.264	2003	Non-free	Joint Video Team
HEVC/H.265	2013	Non-free (unclear)	Joint Video Collaborative Team for Video Coding
VP9	2013	Free	Google
AV1	2018	Free (unclear)	Alliance For Open Media
VVC	2020	Non-free	Joint Video Exploration Team
LCEVC	2020	Non-free	V-Nova

Sources: IABM, streamingmedia.com, wowza.com, muvi.com

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Pricing - From complex royalty fees to free codecs

For example, YouTube has used the VP9 codec for 4K/UHD content, but at the same time it has had to encode in software, which requires five times more computer resources than the old AVC codec. Therefore, VP9 and AV1 are primarily used by the big players like Netflix, Amazon, YouTube and Facebook, because they can afford these other costs - encoding costs, R&D costs and storage costs - that relate to deploying these new codecs when chasing potential bandwidth savings. For smaller players, adopting new codecs only makes sense when they need to enter new market segments like smart TVs, which anyway requires larger investments.

Netflix launches AV1 streams to TVs

In November 2021, Netflix started streaming to TVs and TVs conncected with PS4 Pro using the AV1 codec, which compresses video more efficiently without reducing image quality - enabling streaming more and higher-quality content with less bandwidth. According to Netflix, all its AV1 streams are encoded in the highest available resolution (4K) and HFR, and the conversion to AV1 has been started by re-encoding its most popular content first. The company also revealed that it is working with external partners to enable more devices for AV1 streaming and to soon augment to AV1 with HDR.

> *This [use of the AV1 codec] allows us to present the content exactly as creatively envisioned.*
>
> ***Netflix Tech Blog (11/2021)***

Sources: IABM, streamingmedia.com, whatthifi.com, Netflix

Developments in Codecs

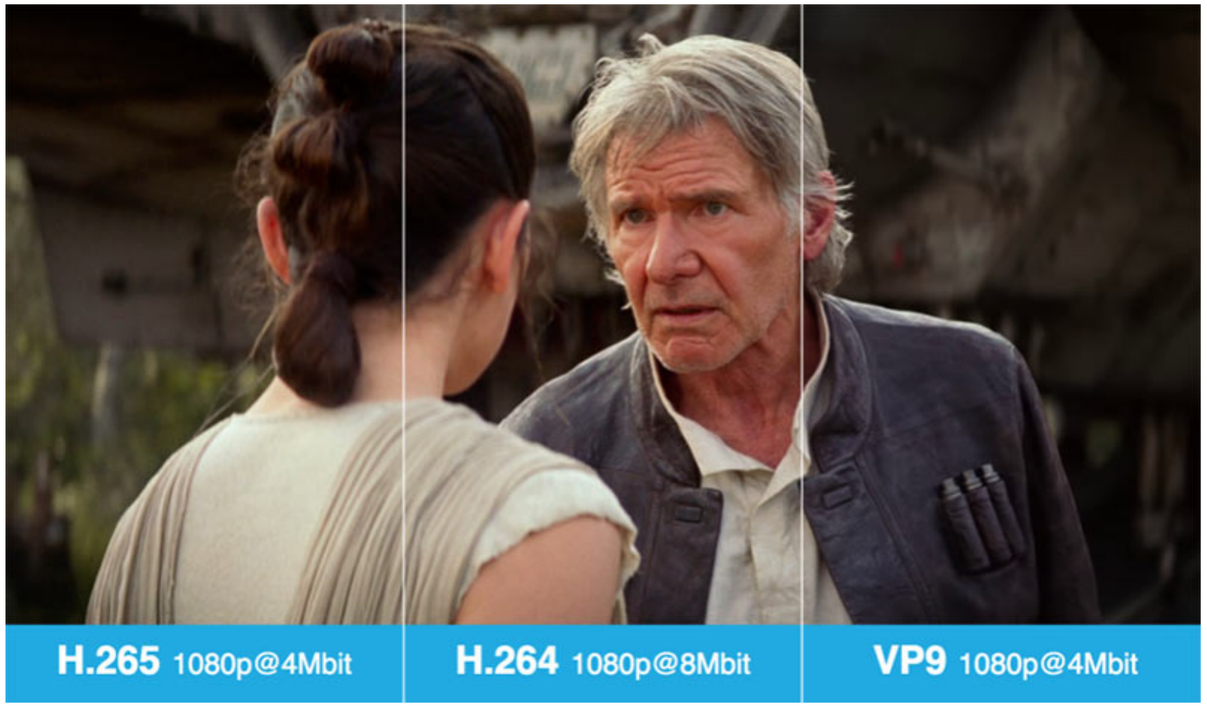
Summary - Implications for media businesses

Media Businesses

New codecs are providing media businesses a competitive advantage for their DTC business, enabling a better, targeted UX with less bandwidth

New codecs enable media businesses to live stream 4K/UHD content with low latency in a remote, decentralized production environment

New codecs allow media businesses to optimize virtual, immersive experiences at a device-level for viewers, supporting their move to more interactive, gamified content



Sources: IABM, Bitmovin