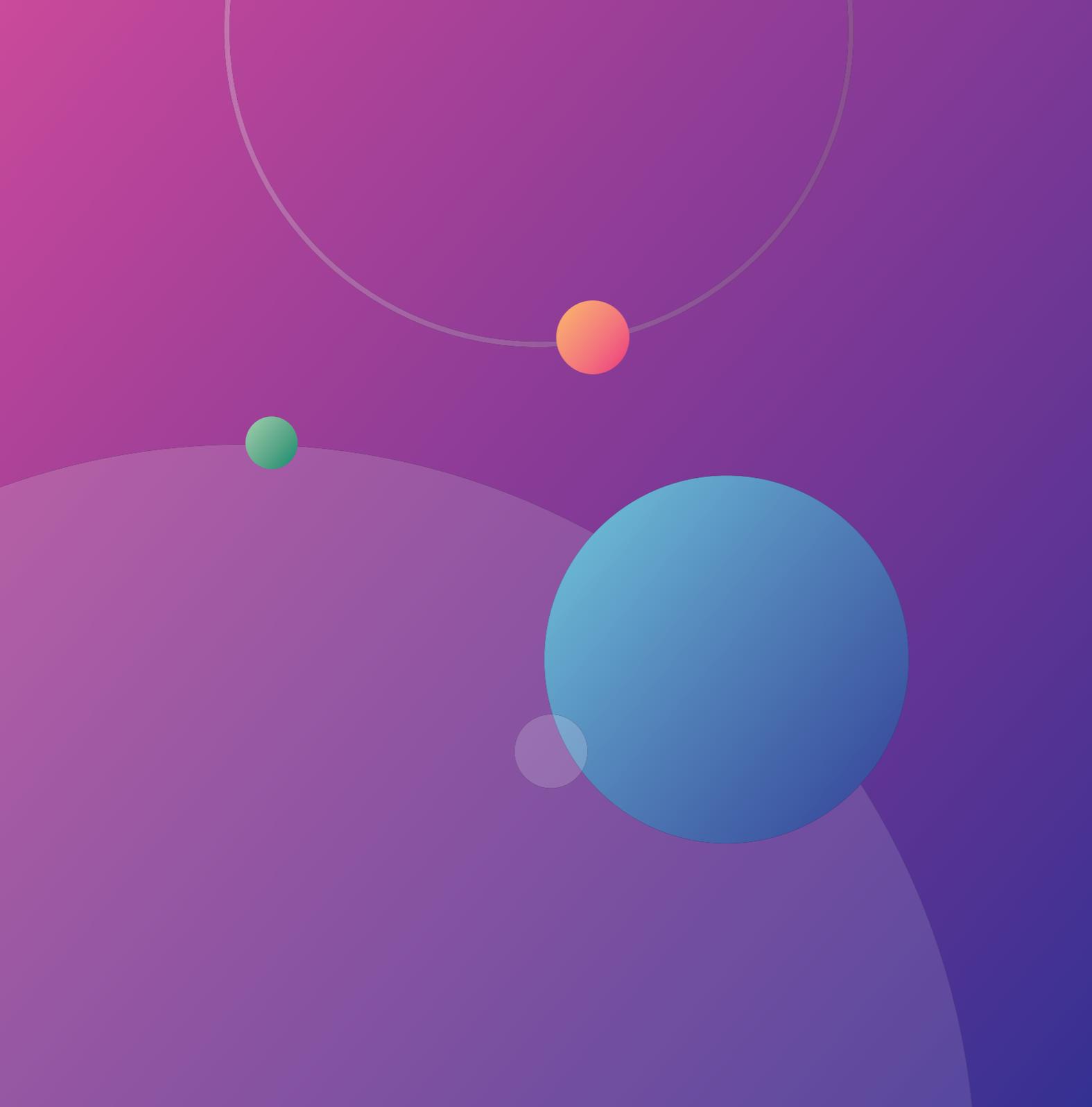


2021
BITMOVIN
VIDEO
DEVELOPER
REPORT



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Welcome

When I was writing my welcome note last year, the world was in a very different place. By no means are we back to normal. We are still dealing with a lot of uncertainties. But with the world slowly beginning to open up again, we've been more than curious to see how it has affected the video streaming industry.

Due to the lockdowns last year, the industry has seen substantial growth rates in terms of increased consumption and accelerated innovation topics, from personalization to video quality optimization. Providing higher quality and more engaging video experiences also surfaced new challenges, such as controlling costs.

Looking at this year's results, we see several indicators across the board that the industry is further maturing. Let me give you an example;

for years, we've been avid supporters and excited about the potential of the AV1 codec. As a company, we believe and acknowledge that it's a multi-codec world, and this year we finally see results indicating that AV1 is ready to be a part of that approach. We have also seen increased usage of more comprehensive content protection systems over the past few years, at least partially driven by increased piracy over the pandemic.

Last but not least, video developers have indicated the rising importance of video analytics platforms in a successful video workflow. Several use cases might have driven that progress. Analytical monitoring gives insights and a detailed understanding of your audience, resulting in the ability to control costs by ensuring resources are in the right place.

With the 5th edition of the video developer report in your hands (or on your screen), we again want to thank you, the video developer community, for providing us with your thoughts and insights and participating in the survey. Regardless of whether you are encoding 10 or 10,000 videos, deploying a player for the first time, or increasing your device coverage while analyzing and monitoring your viewers' experiences, we hope you learn from us as much as we have learned from you.

Wishing you great success in 2022 and beyond!

Stefan Lederer

CEO & Co-Founder Bitmovin

KEY FINDINGS

Changing of the guard?

- When it comes to device reach, there is no way around the AVC/H.264 video codec. However, newer and more efficient codecs, HEVC, VP9, and AV1, all saw significant increases in testing and production usage, with HEVC being deployed by over half of respondents.
- The ecosystem may be ready to make the jump to AV1 considering AV1 adoption by consumer platforms like YouTube and increasing device support from the Fire TV Stick 4K Max.
- For audio codecs, AAC has enjoyed a similar reign at the top – but it did experience some decline this year while multiple Dolby audio formats gained ground.
- HLS has been the most popular streaming format, but its first decline in usage has made way for CMAF, which saw an uptick in adoption, rising from 21% to 26%.

Understanding your audience

- The key to a successful business, regardless of the business model and content type, is understanding your audience. Turn to page 32 to see what devices and platforms the video developers are focusing on.
- To understand your audience, consistent monitoring and analytics are a must. While startup time is still an important performance metric, video developers now often look to other metrics that influence the viewer experience.
- Last but not least, when asked for innovation areas, ‘viewer engagement and consumption’ received 28% of the votes.

The value of commercial solutions

- Media companies have become more mature in their knowledge of the streaming stack and their level of expertise. The value of commercial solutions shines when deploying highly configurable and modular best-of-breed components.
- 54% of the respondents use a commercial encoder (+4% from last year). This could be due to several reasons including the need for higher levels of support, usability, and control. Or to be more specific, the increased complexity of codecs such as HEVC, VP9, and AV1 and Dolby audio codecs.
- Similar reasons will play a role for the 45% of developers that selected the commercial player solution. A commercial solution adds value from deployment to maintenance and testing in the fragmented player landscape.
- The same holds true for analytics solutions where the easy-to-integrate Google Analytics is often supplemented by a commercial solution and over 50% of the developers are using 2–3 data logs to get a better understanding of their audience.

The ongoing challenge with low latency applications

- Last year, the number-one challenge was cost. This year innovation topics like low latency are back on top. This is no surprise, as reducing live latency has been among the biggest challenges faced by video developers over the past several years.
- The majority of respondents expect low latency video in the 3 to 5-second range, while 25% of our respondents expect sub-second delays for the second straight year in a row.

Methodology

This is Bitmovin's 5th annual survey designed to collect, aggregate, and analyze responses to the most burning questions and topics facing video developers.

We conducted the survey from July 7th through August 22nd, 2021. 538 video developers and industry experts from 65 countries participated.

Certain questions in the survey are multiple-choice, multiple-answer questions where the aggregate of the answers will not add up to 100%.

For the first time, we introduced a ranking option for some questions. We have adapted the question lineup to acknowledge new developments and technologies.

While the Bitmovin Developer Survey is open for everyone to participate and we are posting it industry-wide, we want to preface that the results might be slightly skewed towards the Bitmovin customer base.

JOB TITLE

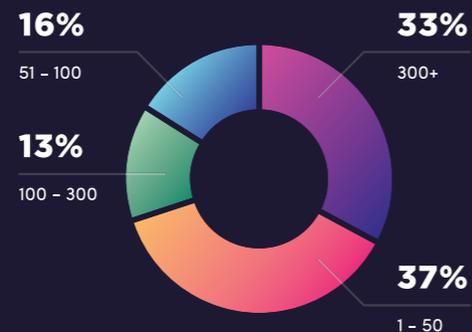
More than two-thirds of the participants hold technical roles, such as developers, solution architects, and product/technical managers; 26% have business roles and 1.3% have research responsibilities.

INDUSTRY

We saw a similar distribution across the industries compared to the previous years.

COMPANY SIZE

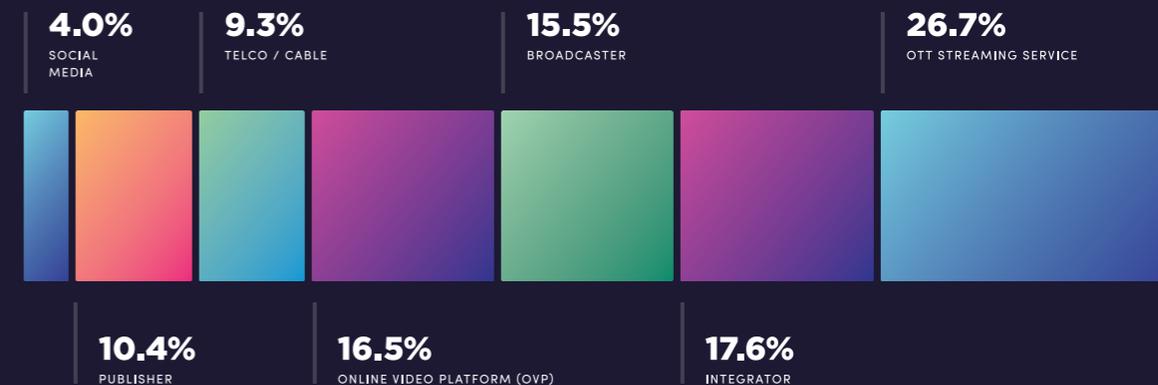
The majority of survey participants came from companies with up to 100 people and made up over 53% of the respondents. 33% are working in entities with 300+ employees.



JOB TITLE



INDUSTRY



Challenges and Innovation

An astronaut in a white spacesuit is floating in space, pointing towards the camera. The background is a vast field of stars and a colorful nebula. The Earth's horizon is visible at the bottom of the frame.

The video streaming industry is both booming and in uncharted waters at the same time. While last year's report was dominated by the impact of COVID-19 on video workflows, we were curious to see what has changed in the past year. Let's have a look and see what challenges keep the video developers up at night and where they see the biggest potential for innovation.

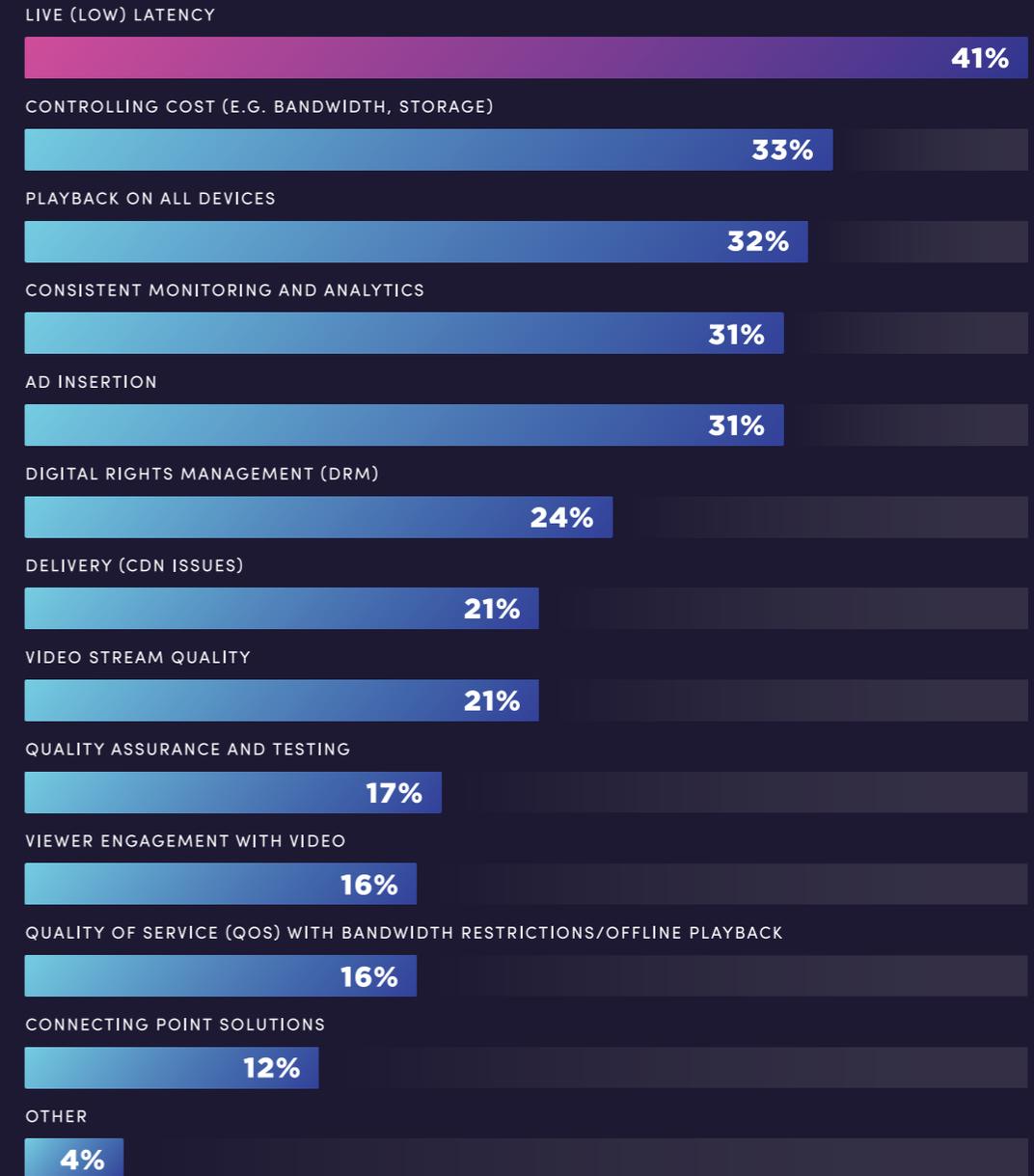
What are the biggest challenges you are experiencing with video technology today?

This is our traditional warm-up question, getting the pulse of what's top of the mind for our survey participants. 'Live Low Latency' is back on top and we dedicated a deeper dive to it on page 26.

'Controlling Cost' is still very high up on the list and has not lost its importance. Overall, the percentages are more evenly distributed – meaning lots of challenges need to be solved simultaneously. This adds complexity,

especially when trying to address competing goals, such as achieving playback on all devices while controlling the cost of storing multiple file types.

Playback on all devices is a constant challenge with new devices and platforms entering the market on a consistent basis. With local differences and preferences, the question is not if, but when you are able to support them to maximize your audience.

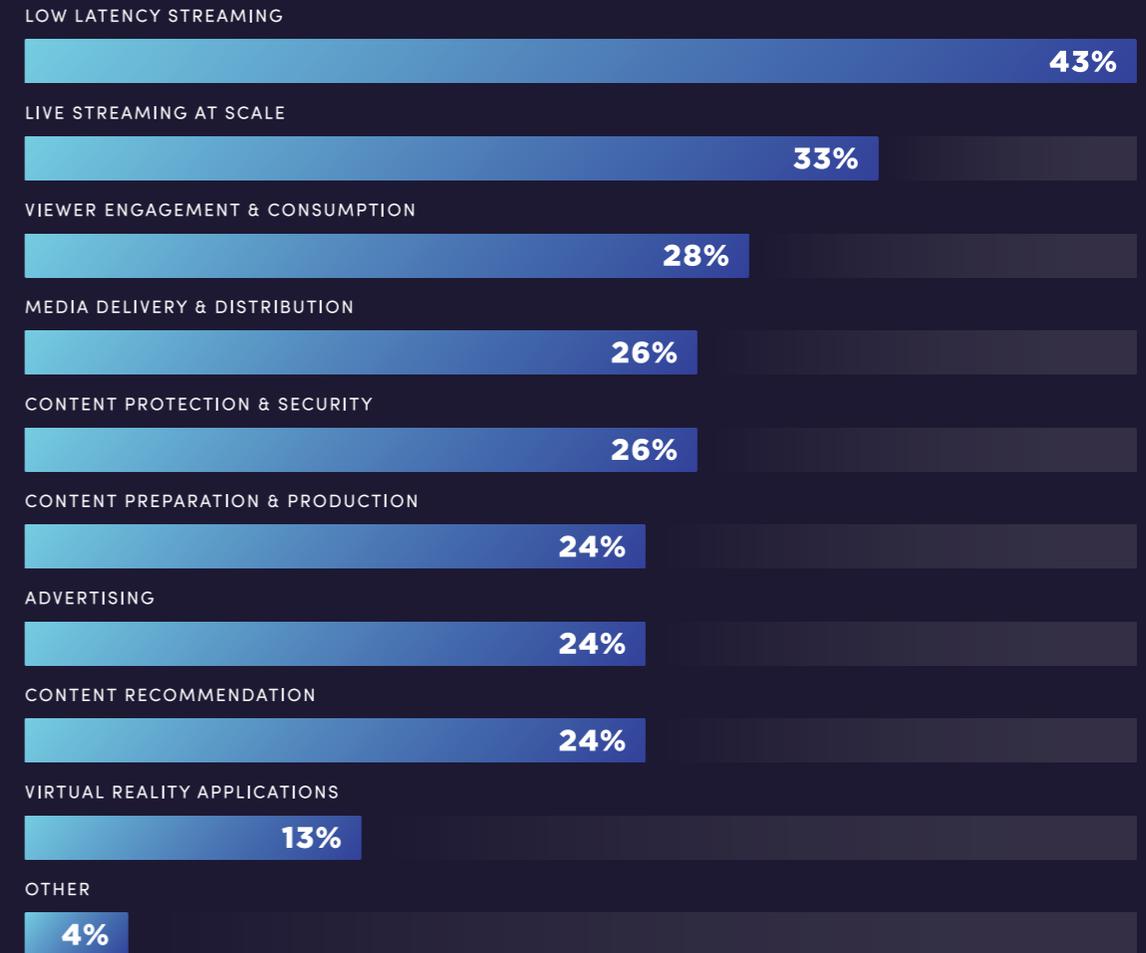


Where do you see the most opportunity for innovation in your service?

We see a new topic topping the chart this year: low latency streaming. However, it is probably fair to say that low latency streaming and live streaming at scale are interconnected. Low latency applications and solutions seem to be in high demand, especially for online video games, gambling, betting and bidding, second-screen experiences, and video chat.

Hence, mastering live streaming at scale proves to be, again and again, the most difficult challenge. Several areas offer room for innovation including reducing latency for interactivity, adopting more data-efficient codecs to deliver higher quality, and multi-CDN and peer-to-peer optimizations to expand and strengthen your delivery footprint.

In this increasingly competitive field, it does not matter if you are streaming live or on-demand – engaging your viewers and getting them to consume more content are the key drivers for differentiation and success. And let’s not forget that video is the most engaging format in online marketing and enterprise communication. A successful platform and service must support interactive video elements.

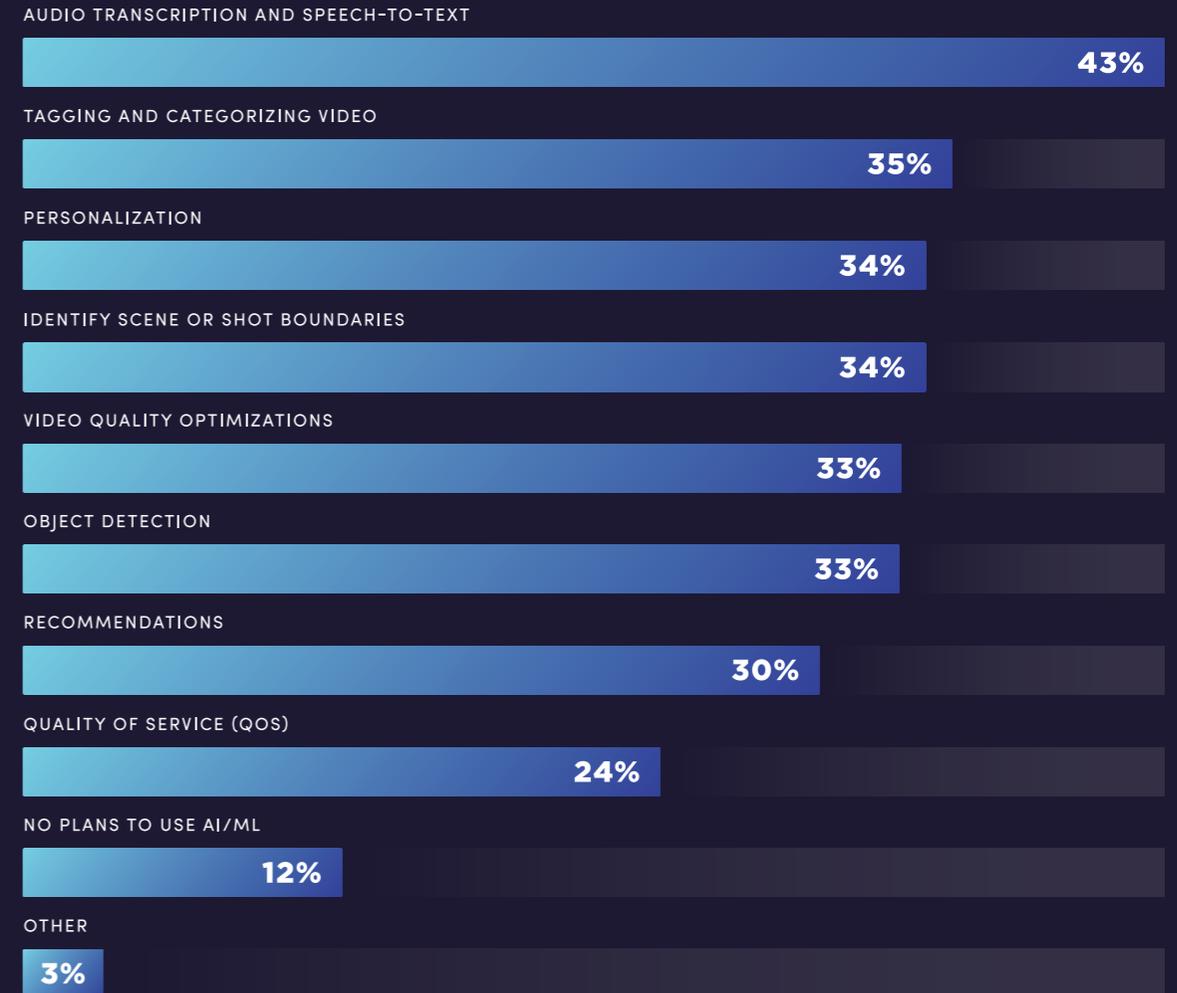


For which of the following video use cases do you expect to use machine learning (ML) or artificial intelligence (AI) to improve the video experience for your viewers?

Recommendations and personalization, which topped the list last year, were surpassed by 'Audio transcription and speech-to-text' and 'Tagging and categorizing video content'.

There are two large benefits inherent to video transcripts. The first is providing closed captions for your video content. Closed captions are a very important aspect of any video strategy. Facebook, for example, discovered that a staggering 85% of video content on their platform was watched muted. As a result, closed captions are crucial to providing context for this growing number of users watching content with no sound.

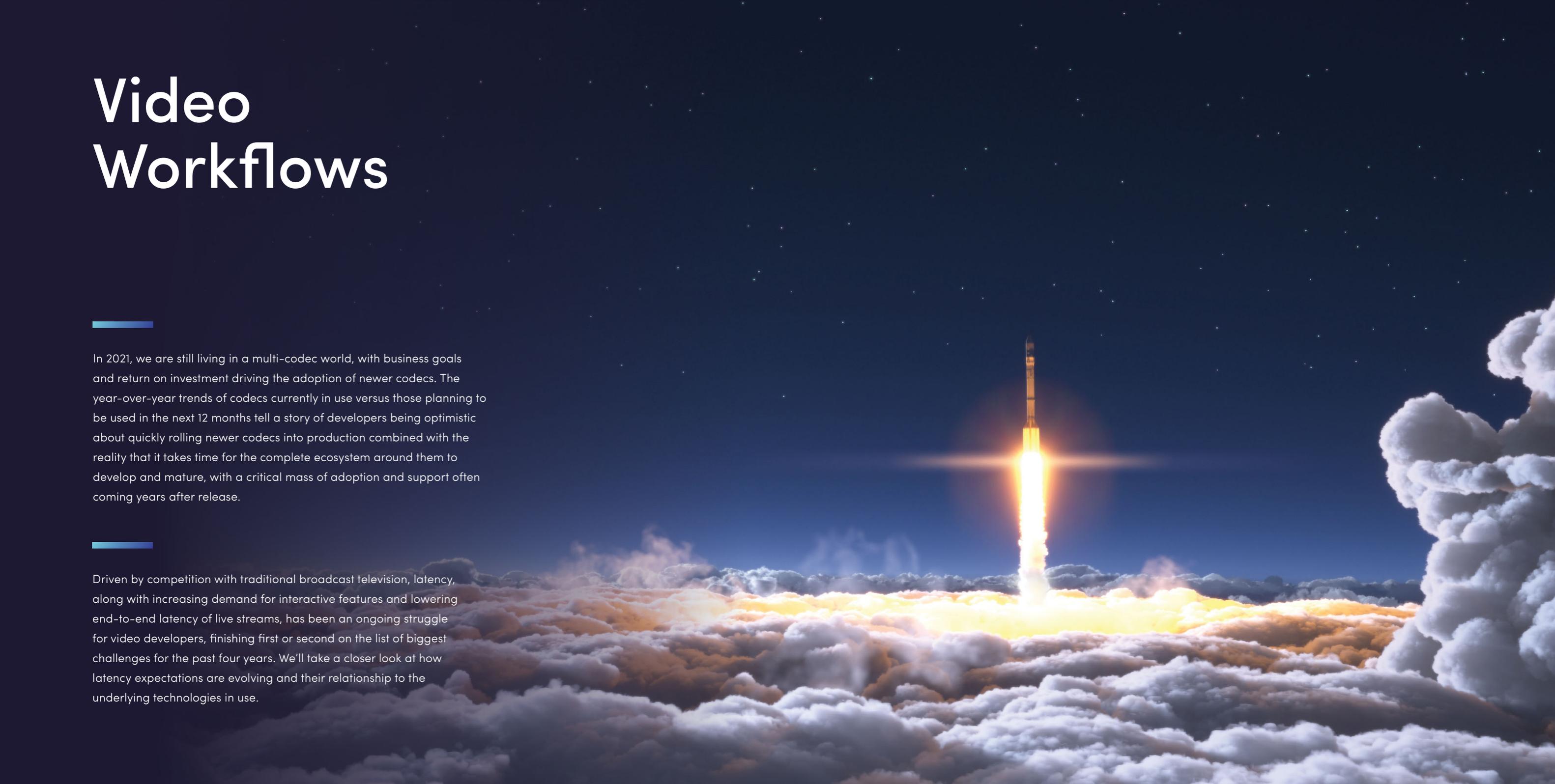
A less obvious benefit for transcripts is the increasing discoverability of video assets. Making content easy to find becomes increasingly important as video archives grow, leading us to the second use case, which is tagging and categorizing video content where the benefits lie in storage, search, and sharing videos.

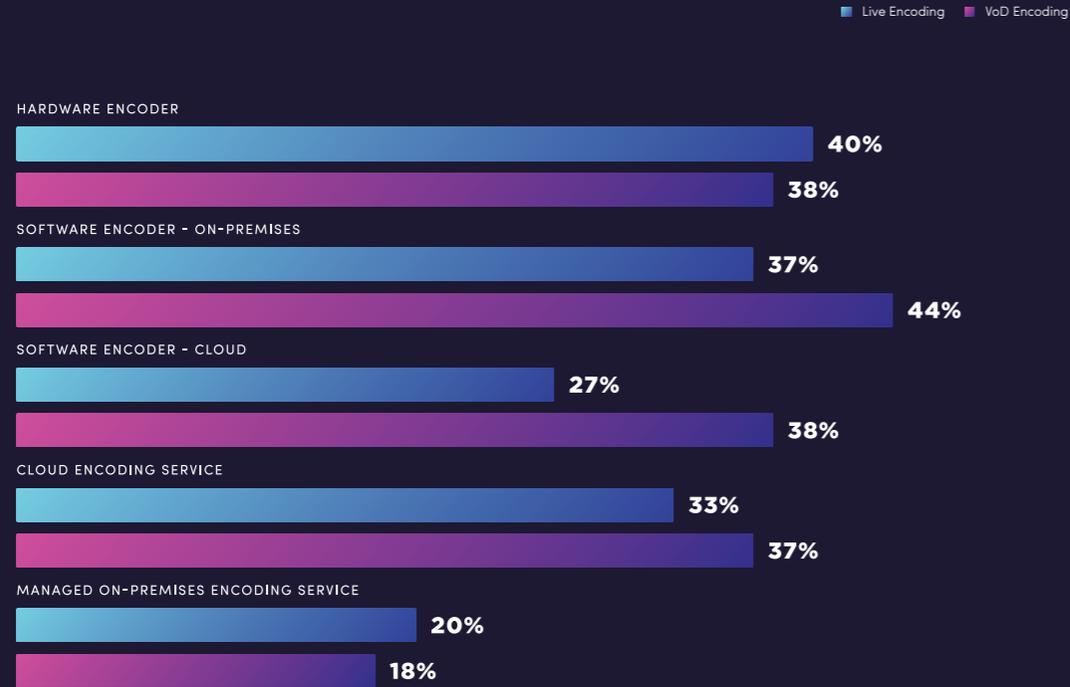


Video Workflows

In 2021, we are still living in a multi-codec world, with business goals and return on investment driving the adoption of newer codecs. The year-over-year trends of codecs currently in use versus those planning to be used in the next 12 months tell a story of developers being optimistic about quickly rolling newer codecs into production combined with the reality that it takes time for the complete ecosystem around them to develop and mature, with a critical mass of adoption and support often coming years after release.

Driven by competition with traditional broadcast television, latency, along with increasing demand for interactive features and lowering end-to-end latency of live streams, has been an ongoing struggle for video developers, finishing first or second on the list of biggest challenges for the past four years. We'll take a closer look at how latency expectations are evolving and their relationship to the underlying technologies in use.





Where do you encode video?

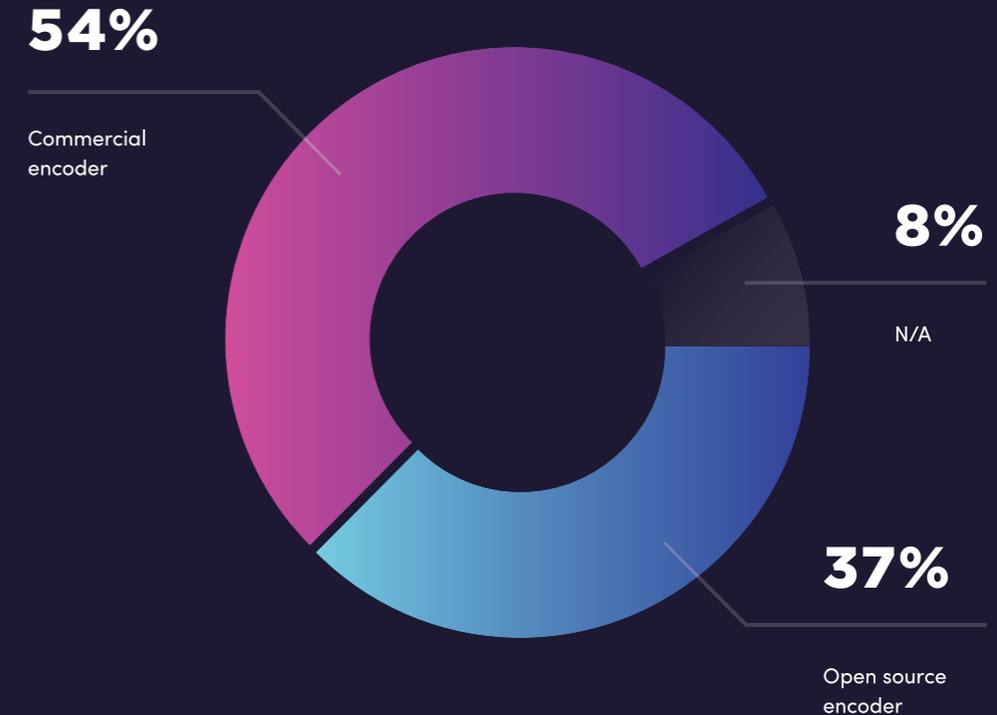
For the first time, we split this question between Video-on-Demand (VoD) and Live Encoding to see what impact content type had on encoding location.

We expected to see larger variances between the two use cases broken down by the encoder location, which led us to check that data confirming the results you see here.

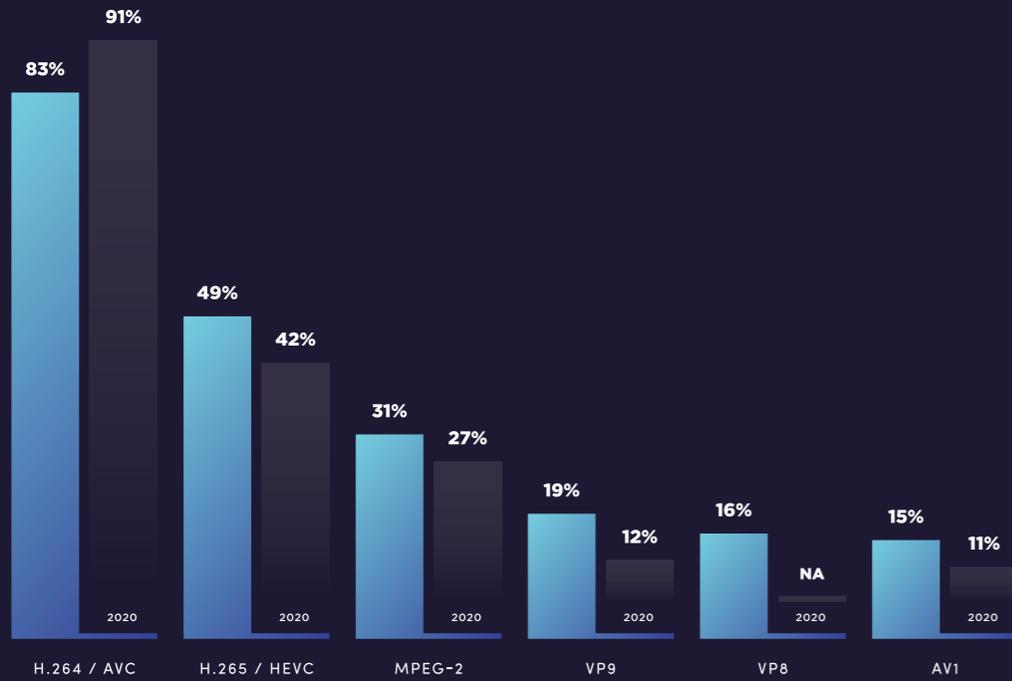
In essence, the use of cloud encoding services is on the rise overall, from 29% in 2019 to 32% in 2020. Now in 2021, 33% of respondents are using a cloud service for Live Encoding and 37% for VoD.

Do you use a commercial encoder or an open-source-based encoder (e.g. FFmpeg)?

We asked this question for the first time in our 2020 survey. Compared to last year, commercial encoders gained 4 percentage points.

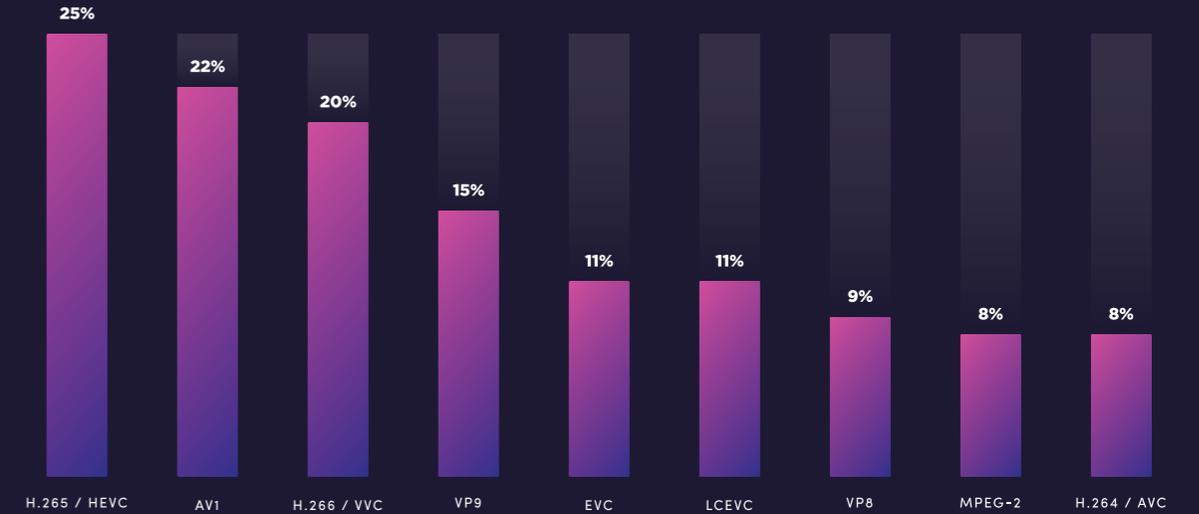


This could be due to several reasons, including the need for higher levels of support, usability, and control. Commercial solutions can offer relief from steep learning curves and maintenance costs for open-source applications, as well as manage the complexity of multiple formats and conversions while providing the highest possible quality.



Which video codecs are you planing to use in the next 12 months?

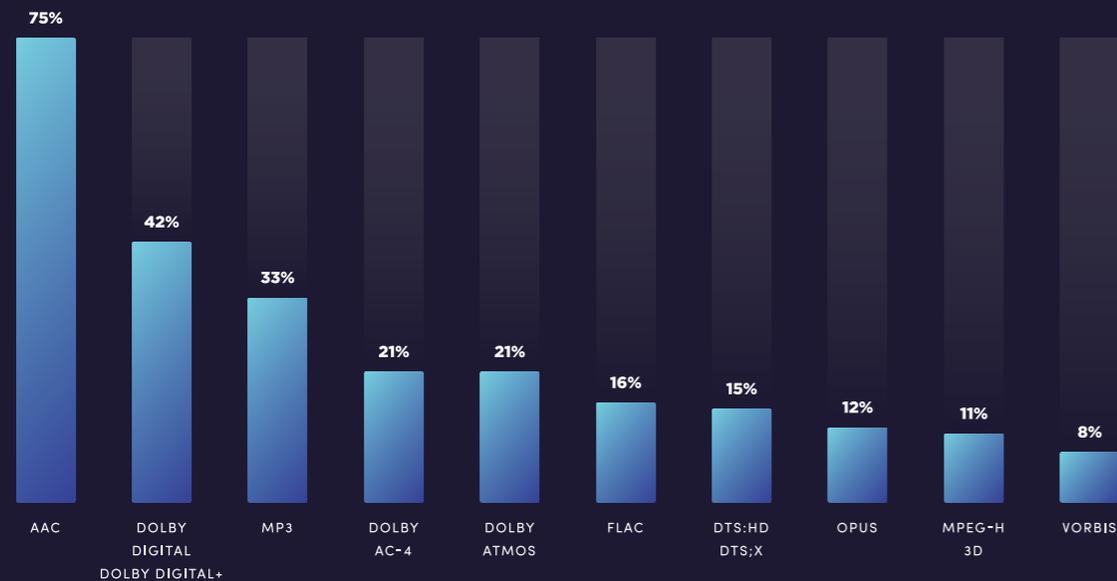
Looking forward, the top 3 codecs projected to be added in the next 12 months are HEVC (25%), AV1 (22%), and VVC (20%), showing that the competition is increasing from the latest generation of codecs. Will AV1 finally have its breakout year? Will VVC really be a viable production option in 2022? Only time will tell.



Which video codecs are you using in production?

Since we began the Bitmovin Video Developer Survey in 2017, AVC/H.264 has been the dominant video codec, utilized by over 90% of participants every year. While still on top, AVC usage declined in 2021, falling by 8% compared to last year.

In 2020, HEVC was being used by 42% of respondents, with an additional 47% saying they planned to add it within the next year. This year, we see HEVC adoption has grown to 49% of participants, a significant increase though somewhat short of last year's ambitious goals. Will 2022 be the year for HEVC or will newer codecs slow its momentum?

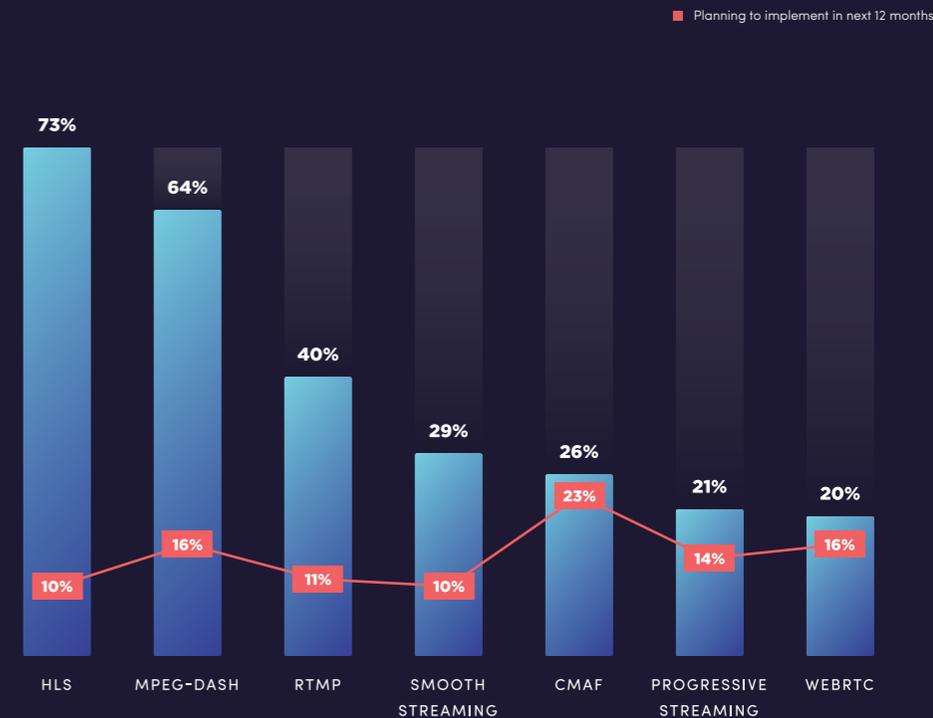


Which audio codecs are you using in production?

While AAC maintained its leadership position, dominating the market with usage by 75% of this year's respondents, its market share did decline from last year by 12 percentage points.

Multiple audio codecs from Dolby gained ground in 2021, led by Dolby Digital/Dolby Digital+ which jumped 7 percentage points and is being used by almost half of survey participants.

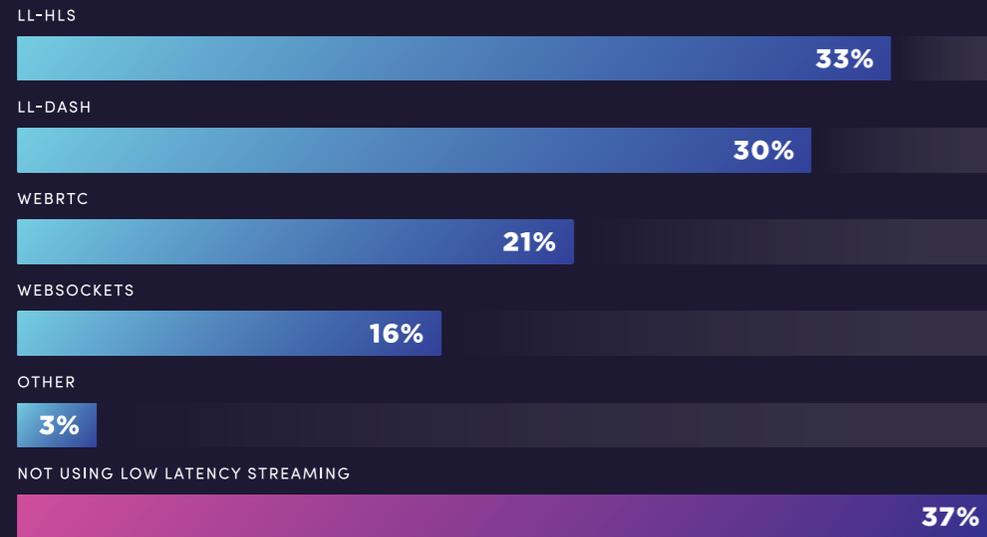
Stalwart MP3 maintained its third-place position followed by Dolby AC-4. Dolby Atmos finished fifth and it will be interesting to see if there are any major shake-ups in the 2022 rankings.



Which streaming formats are you using?

As in previous years, the shifts in new streaming format adoption were mostly incremental. The one exception is CMAF (HLS/DASH) which rose 5 percentage points from last year and is now being used by 26% of respondents.

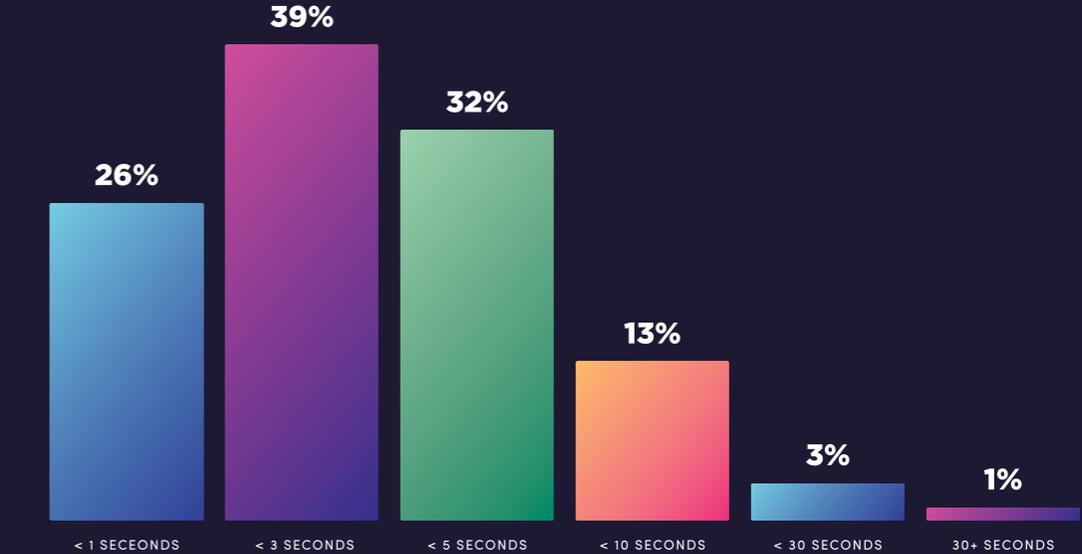
RTMP continues to retain a solid user base utilizing it for live encoding contribution feeds and direct streams to social platforms. It has even outlasted the Flash players it was originally developed for, which is surprising due to the fact that large CDNs have stated they will not support the format going forward.



Which technology do you use for low latency streaming?

In our 2020 report, nearly 60% of participants indicated they were using HTTP-based protocols for low latency streaming. As a result, this year we broke that category down further into LL-HLS and LL-DASH. Not surprisingly, these protocols topped the chart with LL-HLS being used by 33% of respondents.

It will be interesting to follow this trend over the next year with more devices and platforms supporting Apple's still relatively new LL-HLS standard. In the next question, we'll look at low latency expectations and how they've shifted over the past few years.



What is your low latency expectation for Live streams?

In our 2020 report, 60% of respondents said their low latency expectation was <5 seconds, which we noted was a more realistic goal for scalable events and environments compared to the 25% who were expecting less than 1 second.

A low latency expectation of <5 seconds had been the runaway winner the past 2

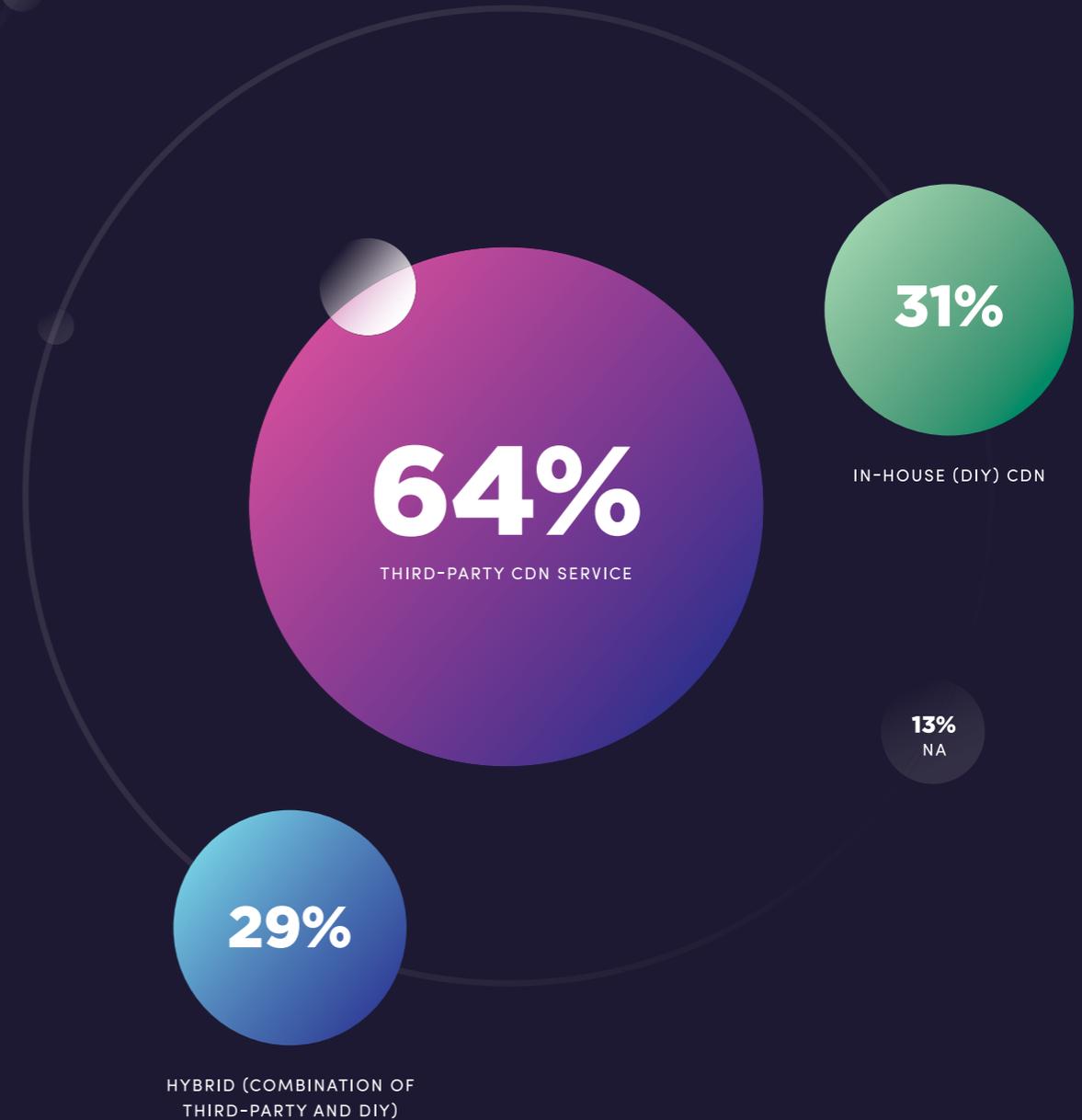
years, so to dig a little deeper, this year we added another option of "<3 seconds" which interestingly was the favorite, chosen by 39% of respondents.

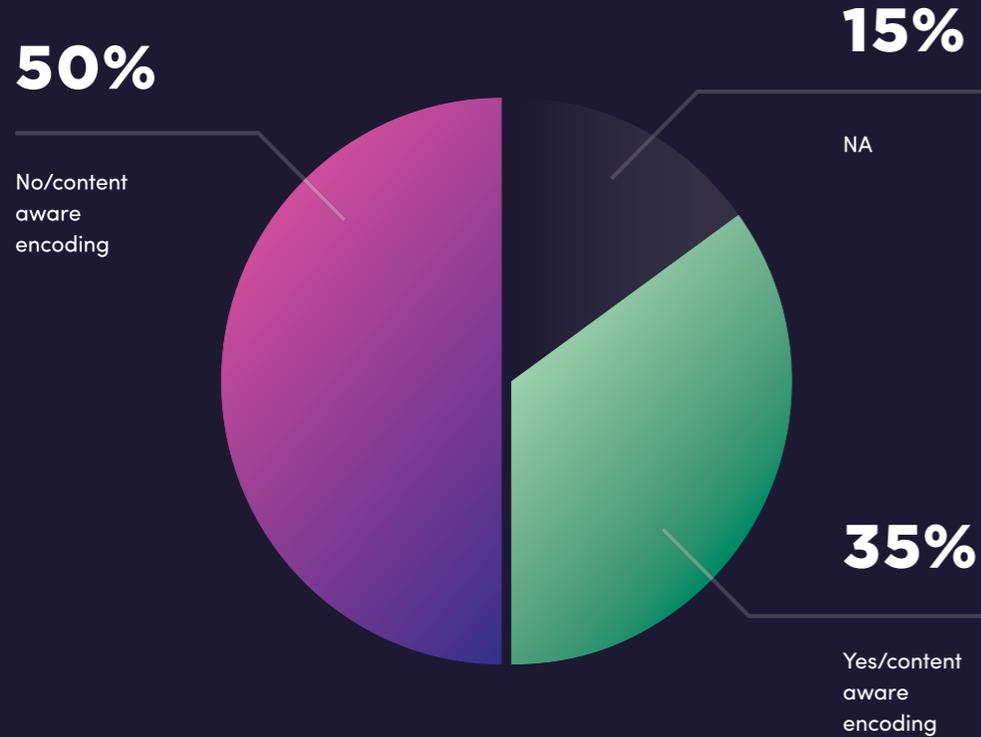
Latency expectations and requirements are largely influenced by the application, with a natural divide between real-time communication and one-to-many broadcasts. These results indicate that for one-to-many applications, both the underlying technologies and developer expectations are evolving to meet in the more achievable 2 - 5 second range.

Which CDN solution are you using?

The boom in video content being delivered across devices to a global footprint has created new challenges for CDN solutions and use cases. Even though building your own CDN is faster and easier than ever, and enables unprecedented customization possibilities, third-party CDN services still have a comfortable lead as the cost of owning

your own can be prohibitive. Lately, many companies have started to implement their own private hybrid content delivery networks to match the need for flexibility. It is clear that this choice has strong appeal with 30% of respondents already using a hybrid model.

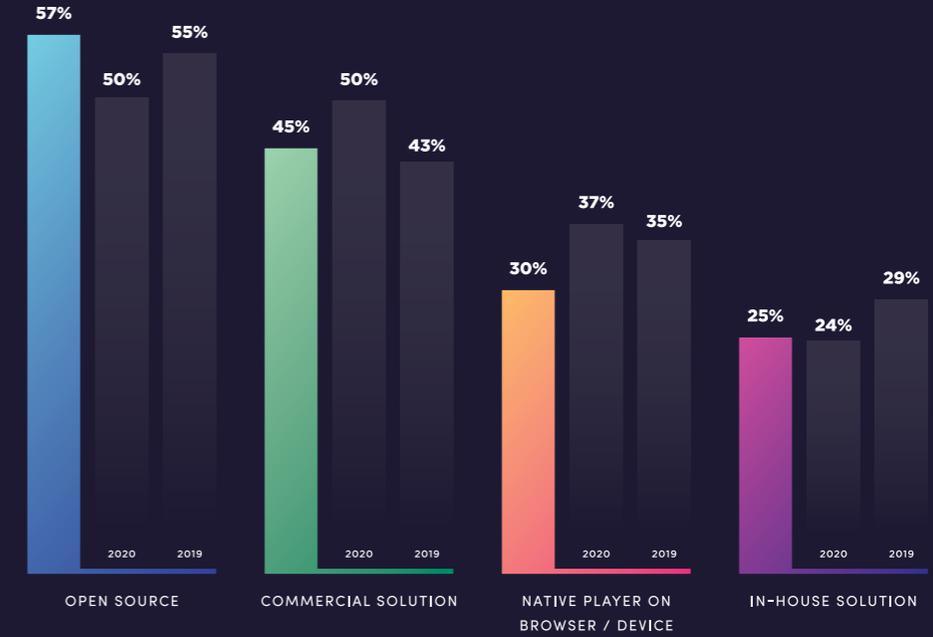




Are you using content-aware encoding technology?

The quality improvement and bandwidth-saving advantages of content-aware encoding are becoming more widely

known, with nearly double the utilization of last year's survey. We predict this trend will continue, as per-title and per-shot encoding optimizations become necessary to lower the total cost of ownership while maintaining the highest possible quality.



Which player codebase are you using?

We think everyone agrees that a well-functioning player is more complicated than meets the eye. It is clear that the increasingly fragmented multi-device world is here to stay. Year-over-year there is little movement when it comes to picking a core player framework.

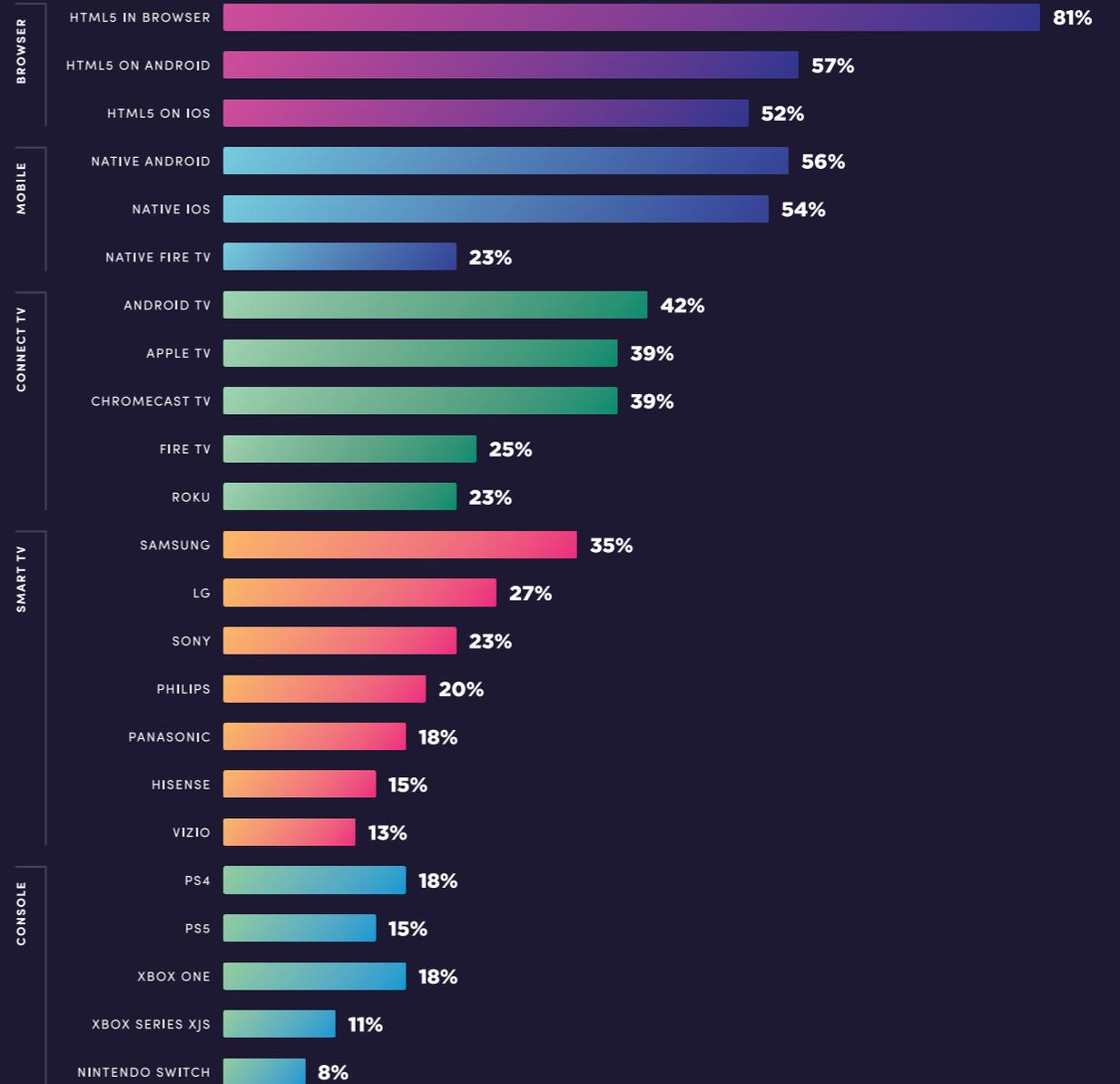
One trend is slowly emerging. This is the declining usage of in-house solutions and native players, which may stem from different challenges. The decline of in-house players might be rooted in the fact that it is easier for developer teams to build on top of an open-source or commercial player codebase. Additionally, in the multi-device world using a native player for each device means developers need to learn a different API each time. Respondents may be favoring using the open-source and commercial players they already know but across more devices.

Which of the following platforms and devices do you use to stream video or audio content?

The accessibility of OTT content is one of the many reasons it is so popular. All of the major video streaming subscription services allow watching on multiple devices and consumers expect a smooth and seamless experience.

As predicted, our list of supported devices grew from last year. And that is the main change and challenge.

The number of devices and high viewer expectations also begs the question of how to test streams across the board without incurring major costs.

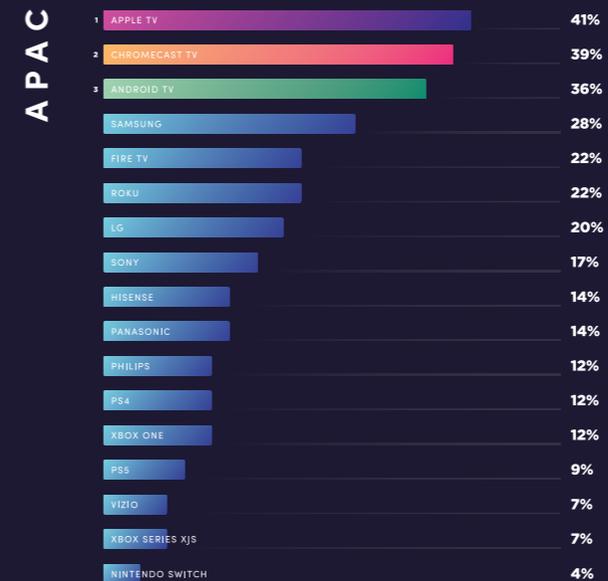
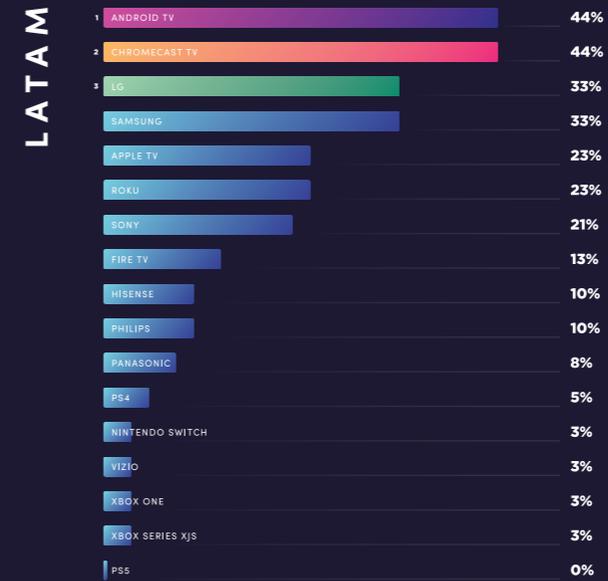
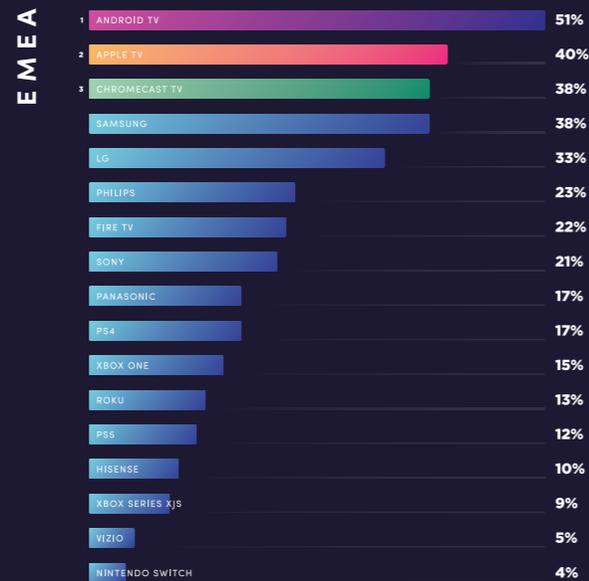
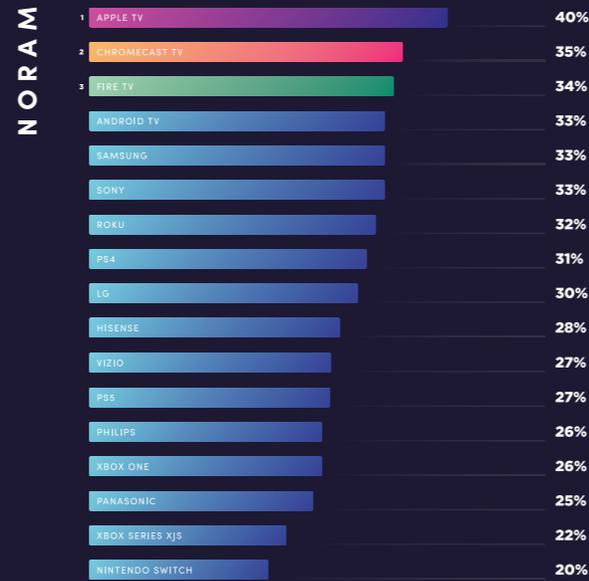


BY REGION

Which of the following platforms and devices do you use to stream video or audio content?

Regional differences are always insightful. Apple TV, Android TV, and Chromecast are in the top positions across the board with Fire TV and Samsung landing in the third spot in North America and Latin America, respectively.

The differences are definitely apparent among the Smart TVs - e.g., Philips ranks high in EMEA and Vizio in North America. Consoles are most popular in the North American market for video streaming where they received double digits, while in all other regions, the numbers are significantly lower. The highest-ranked console everywhere is the PS4.

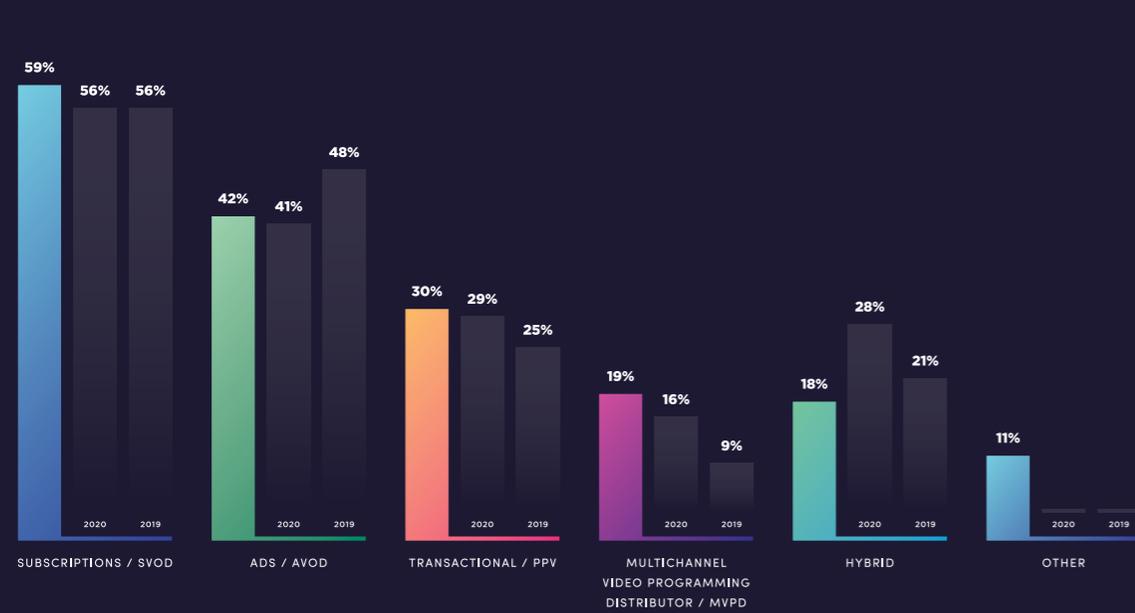


Business insights



For the business side of the developer work, we think it comes down to how well you understand your audience. It's all about the data - which helps streaming providers and their developers optimize their decision-making in balancing decisions about monetization models, content protection, ad architecture and more.

Hence our analytics section is bigger and more insightful than ever - just like analytics services and use cases at the developers' disposal.



What monetization model do you follow?

The media industry is audience and content-driven. When choosing the right revenue model, a flexible technology solution that supports different monetization models can be pivotal. Over the last three years,

our survey has shown only small changes with both the pay-per-view model and multichannel video programming distributor (MVPD) gaining traction year over year.

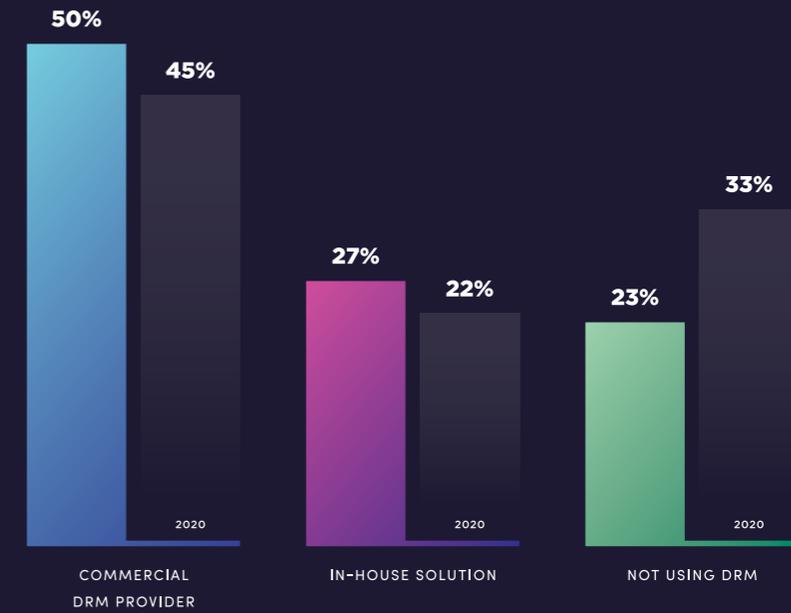
It comes a bit as a surprise that the hybrid model has seen a decline of 10 percentage points this year, considering that several of the bigger services such as HBO, Peacock, and Paramount follow this model.

How are you implementing DRM in your workflow?

'Commercial DRM providers' and 'in-house' solutions are being used more widely while fewer respondents have indicated 'not applicable'. This is a positive trend reflecting

industry and developer awareness of the importance of content protection.

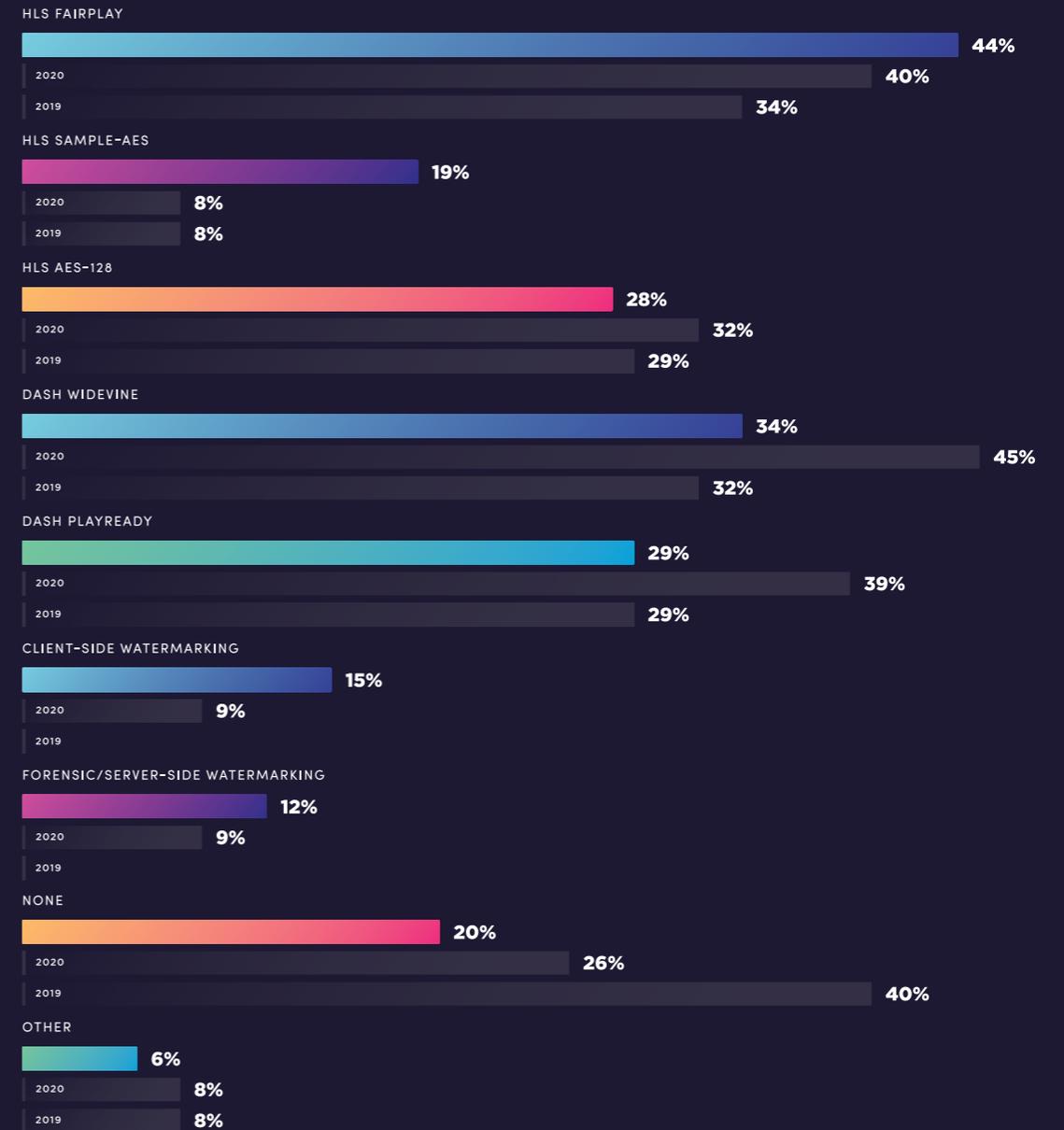
The vast majority of web browsers, devices, and set-top boxes now have native support for at least one of the 'big three' DRM systems. Let's see how Google's Widevine, Apple's FairPlay, and Microsoft's PlayReady fare in the next question.

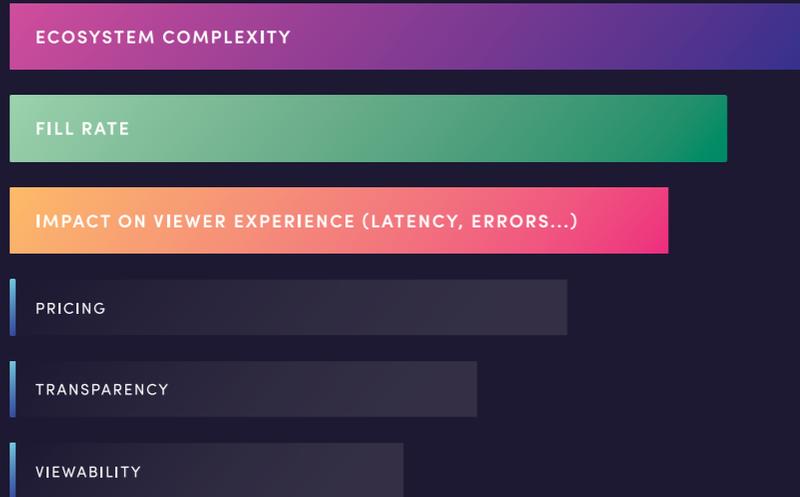


What kind of content protection systems do you use?

According to an investigative report developed by Digital Citizens Alliance, in collaboration with NAGRA, the video piracy ecosystem generates over one billion dollars of revenue annually in the U.S. alone, so content protection solutions around Multi-DRM and forensic watermarking are crucial for preventing lost revenue and jobs.

Notable again is the fact that the percentage of developers not implementing DRM keeps going down year after year – from 40% in 2019 to 26% in 2020 and this year to 20%.



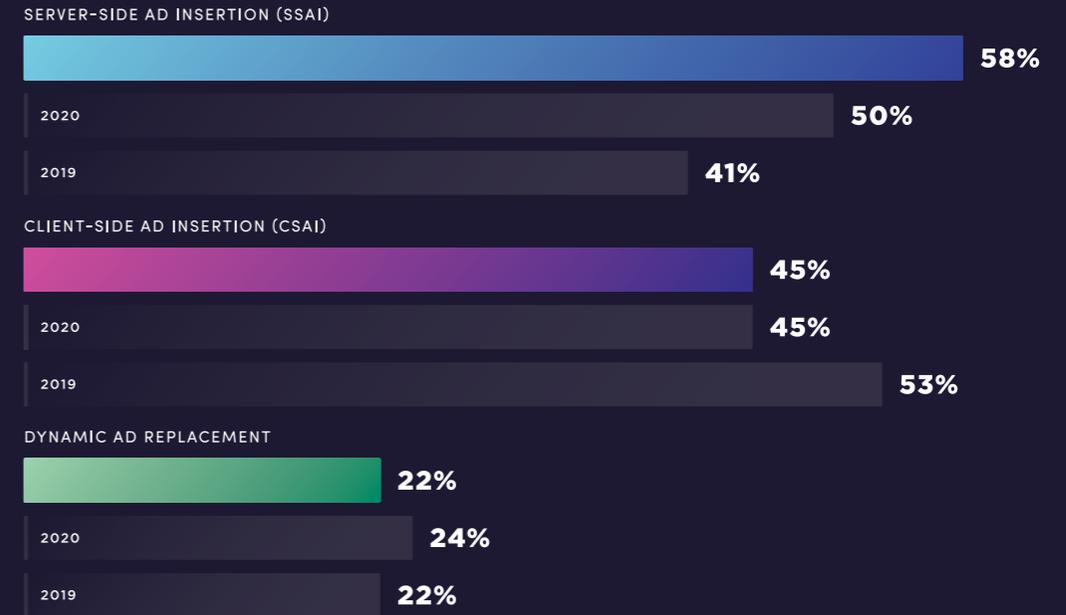


When running ads, what areas are you most concerned about?

Advertisers are eagerly tracking consumer preferences and pumping a higher percentage of their ad budget into OTT. We asked participants to rank the areas that developers are most concerned about when running ads.

Similar to challenges elsewhere in the streaming ecosystem, advertising is challenged by a fragmented ecosystems. Pricing aside, when it comes to low fill rates, the culprit is often technical in nature with issues such as server timeouts or ad placement issues due to device type or geo-targeting.

We are not surprised the 'Impact on Viewer Experience' made it into the top 3. Buffering, errors, and video start delays can all cause viewer dissatisfaction and in a worst-case scenario - churn.



Which ad architecture are you using today?

Both server-side ad insertion (SSAI) and client-side ad insertion (CSAI) have their pros and cons and their place in ad-serving technology for OTT. One trend we've been seeing since we started the survey is that SSAI seems to always be one step ahead of CSAI.

For media companies that are uncertain which ad architecture will be best suited for them, the recommendation is to look at raw, fundamental data that gives insights into the performance of ads in regards to buffering, latency, fill rates, device support, completion rates, and where most of the errors are coming from. This is a nice transition into our last set of questions about video analytics.

What video analytics provider do you use today?

Let's start with the good news for video analytics (providers). Year over year, fewer respondents are answering this question with 'none.' In an increasingly competitive market, video analytics plays a pivotal role in monitoring viewer experiences and engagement and gaining audience insights.

The most popular platform for video analytics over the past two years has been Google, which lost 15 points and was overtaken for the #1 spot taken by in-house solutions. It seems that simple traffic and completion rates might not be enough anymore.

Based on the comments we received, the main reasons for developing and maintaining an in-house solution are security ('Data is at the core of all of our products and we need to own it and make sure we don't gather anything that can identify the viewer.') as well as customization ('We build it ourselves and it gives us all the details we need in a single place.')

Specialized video analytics providers – such as Conviva, Bitmovin, Nice People at Work, Mux and others – provide value with their dedicated focus on the quality of experience (QoE), the actual individual viewer experience, video performance, and advertising insights via dashboards and alerts.

IN-HOUSE VIDEO ANALYTICS

39%

GOOGLE ANALYTICS

37%

CONVIVA

20%

BITMOVIN ANALYTICS

19%

MUX

12%

NICE PEOPLE AT WORK

11%

MEDIAMELON

9%

TOUCHSTREAM

6%

AGAMA ANALYTICS

5%

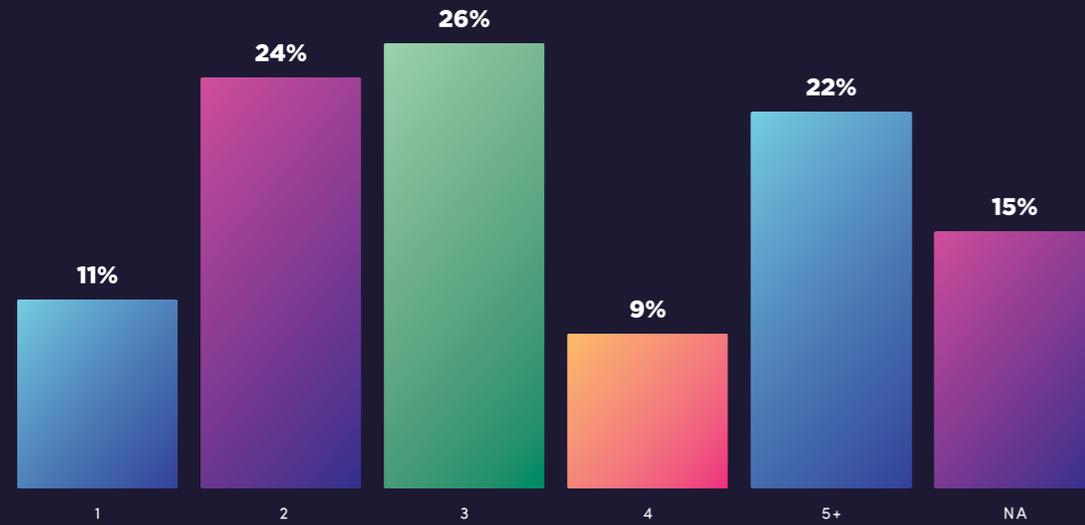
OTHER

10%

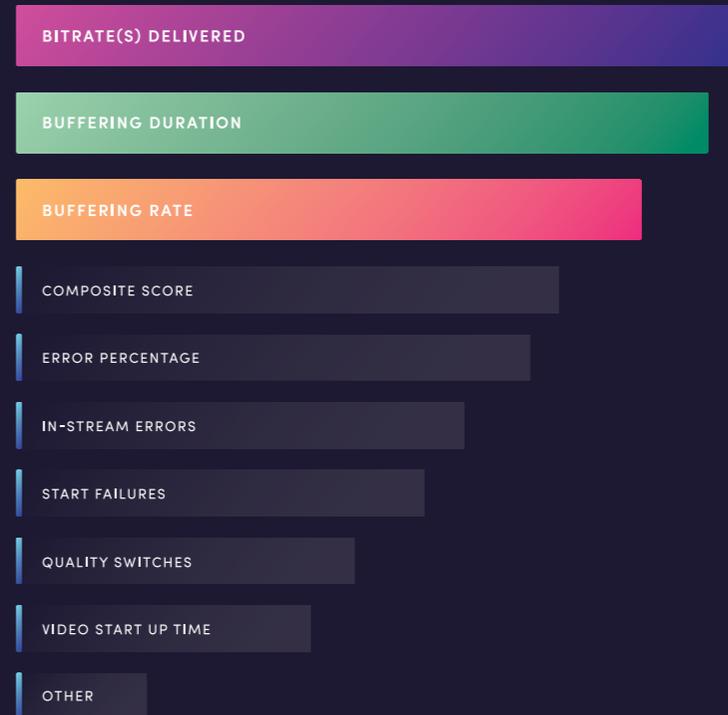
NONE

13%

Participants indicated that they often use a combination of logs because it gives them the most data about how viewers are experiencing video.



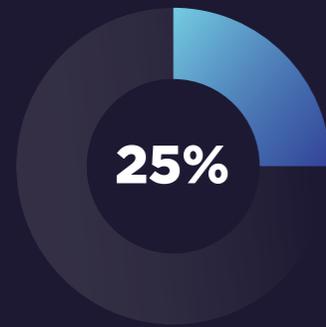
How many sources do you collect video-streaming-related data from?



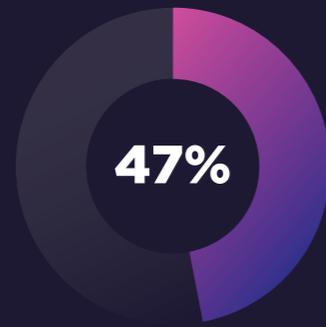
What video performance metric is most important to you?

We understand that there is more than one performance metric that is important. But in the past years, video start-up time led this chart.

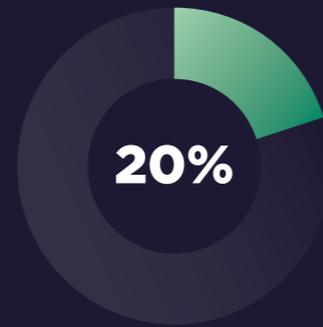
What does this new ranking tell us? It indicates that while the initial startup of a video is still an important part of the viewer experience, as soon as a provider has mastered it, they can focus on other metrics that influence the viewer experience and, even more so, customer retention.



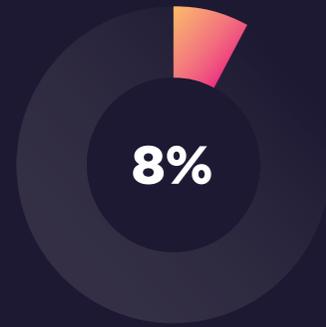
LESS THAN 1 HOUR



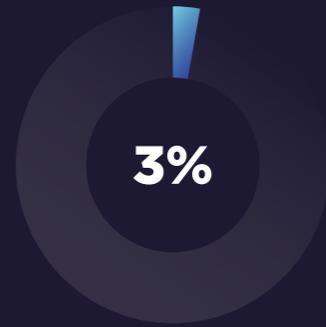
BETWEEN 2 - 12 HOURS



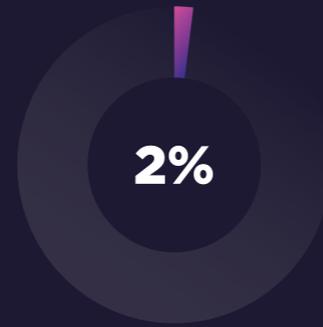
BETWEEN 12 - 24 HOURS



MORE THAN 1 DAY



MORE THAN 7 DAYS



OTHER

How many hours per month does your development team spend on maintaining your video streaming analytics solution?

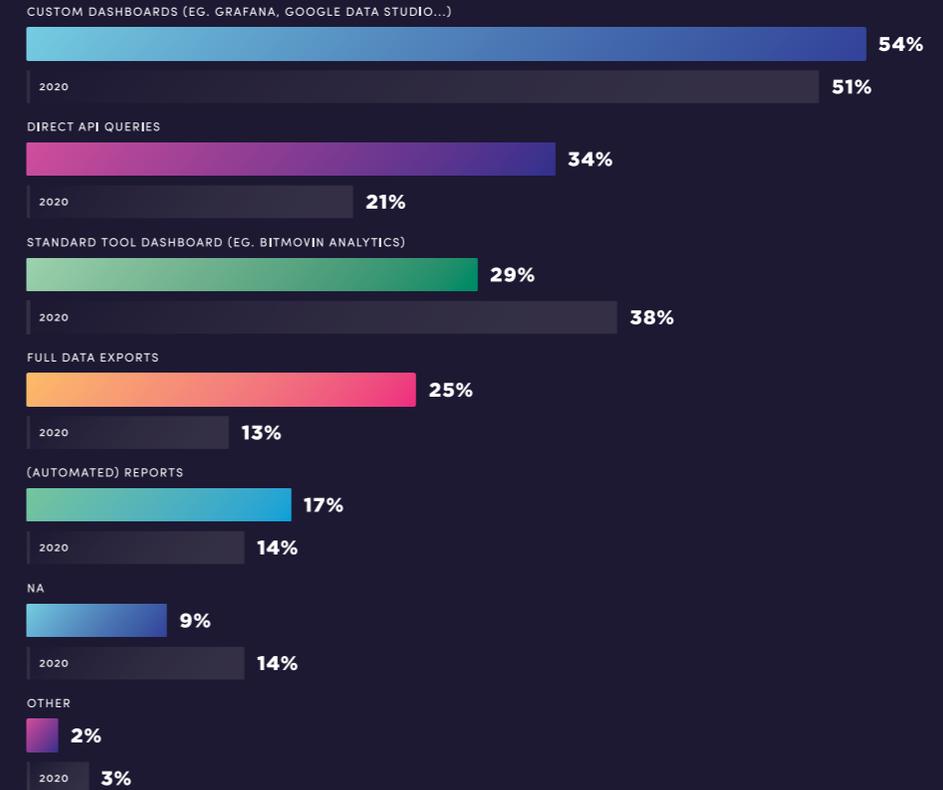
Regardless of whether you use an in-house solution or an analytics provider, the time commitment for the development team is significant. It is important to look for a solution that is easy to integrate and maintain, while also allowing root cause analysis for identified errors.

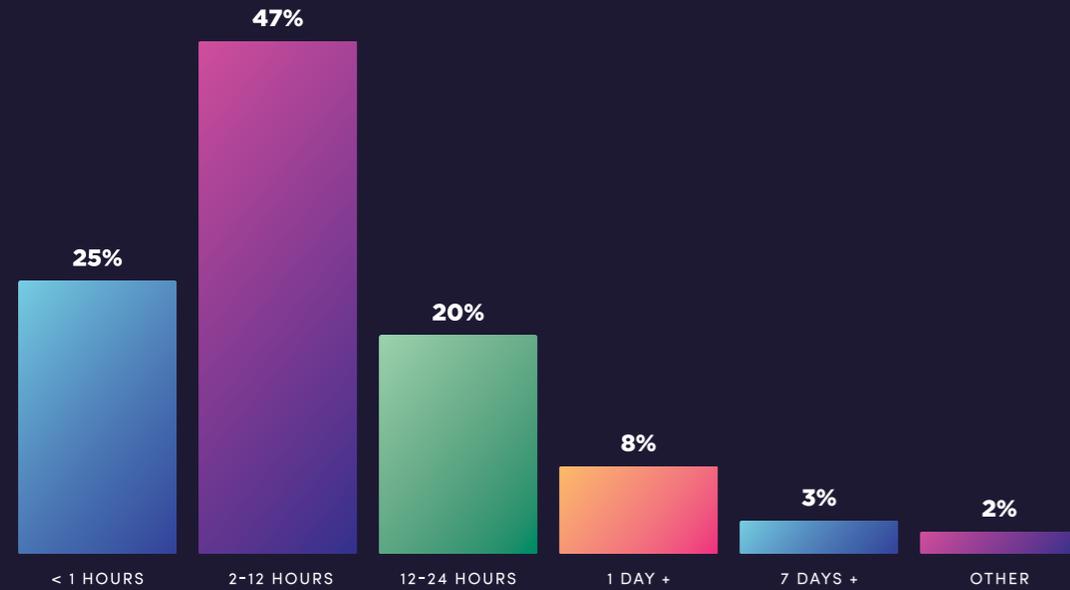
How do you access video analytics data?

The answers to this question paint a similar picture to the year before. The majority of respondents want to see the data populated in custom dashboards. Integrations with vendors such as Grafana, Google Data Studio,

and Tableau are critical for any video analytics platform and solution, especially when the dashboards are monitored by humans basing important decisions on the data.

Direct API queries are gaining in popularity, but for a different use case. The focus here is to build actionable insights and automated decisions based on the data.



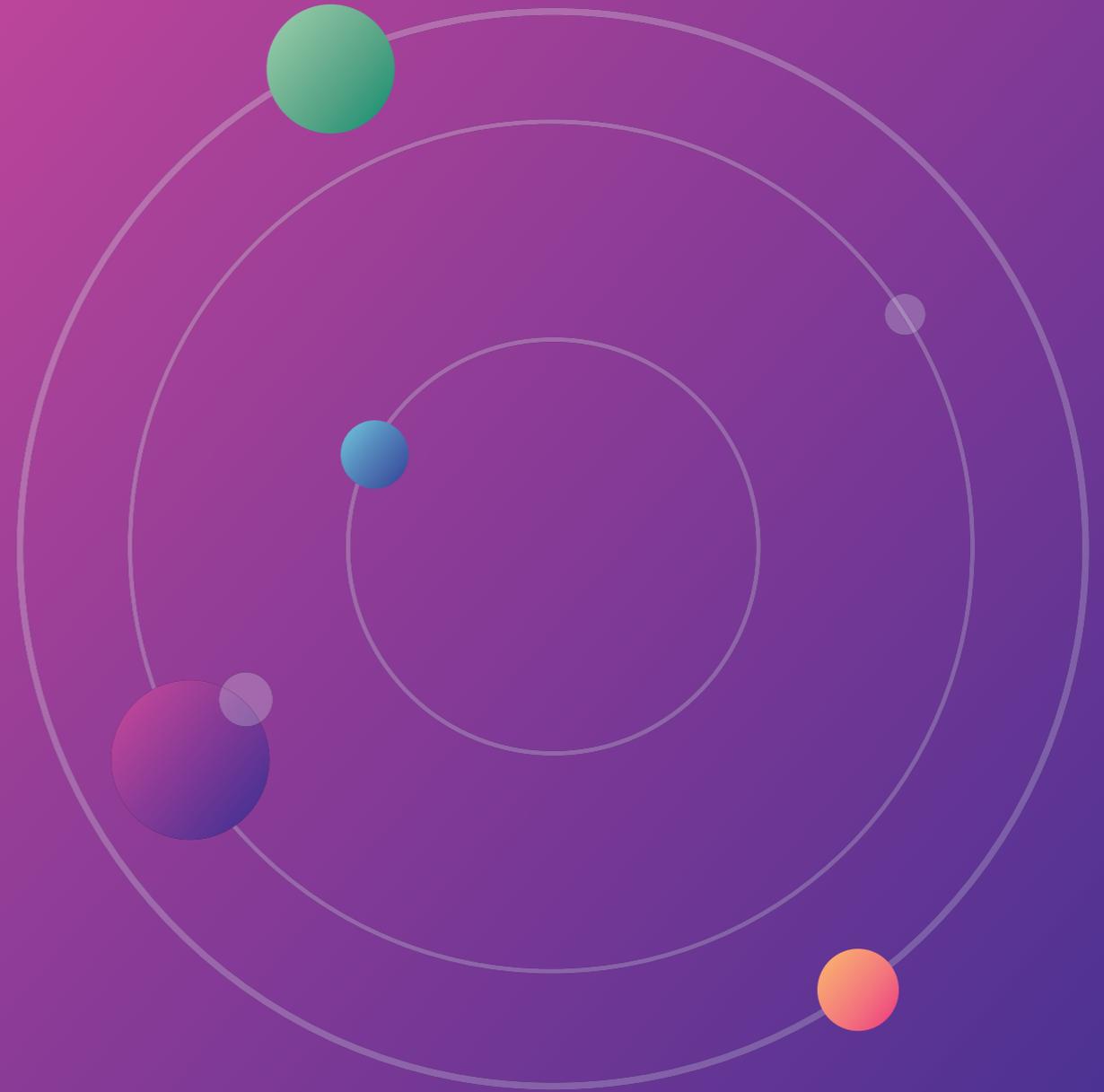


On average, how long does it take your team to find the root cause of a streaming-related issue?

The video streaming industry is fast-paced. Errors are inevitable and occur across all devices and platforms. Worse, viewers have very little patience when streaming

errors occur and their viewing pleasure is interrupted. That means each error has a monetary impact regardless of the business model. Reducing the time to find the root cause can minimize customer churn and revenue loss.

Granular data sets drilling down without having to replicate error messages can be the holy grail to reduce the time to identify and fix errors.



Bitmovin is an Emmy® Award-winning leading global provider of video software and cloud infrastructure for online media companies and enterprises. Built for technical professionals in the OTT video market, Bitmovin's software solutions are designed to optimize customer operations and reduce time-to-market, resulting in the best viewer experience imaginable.

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