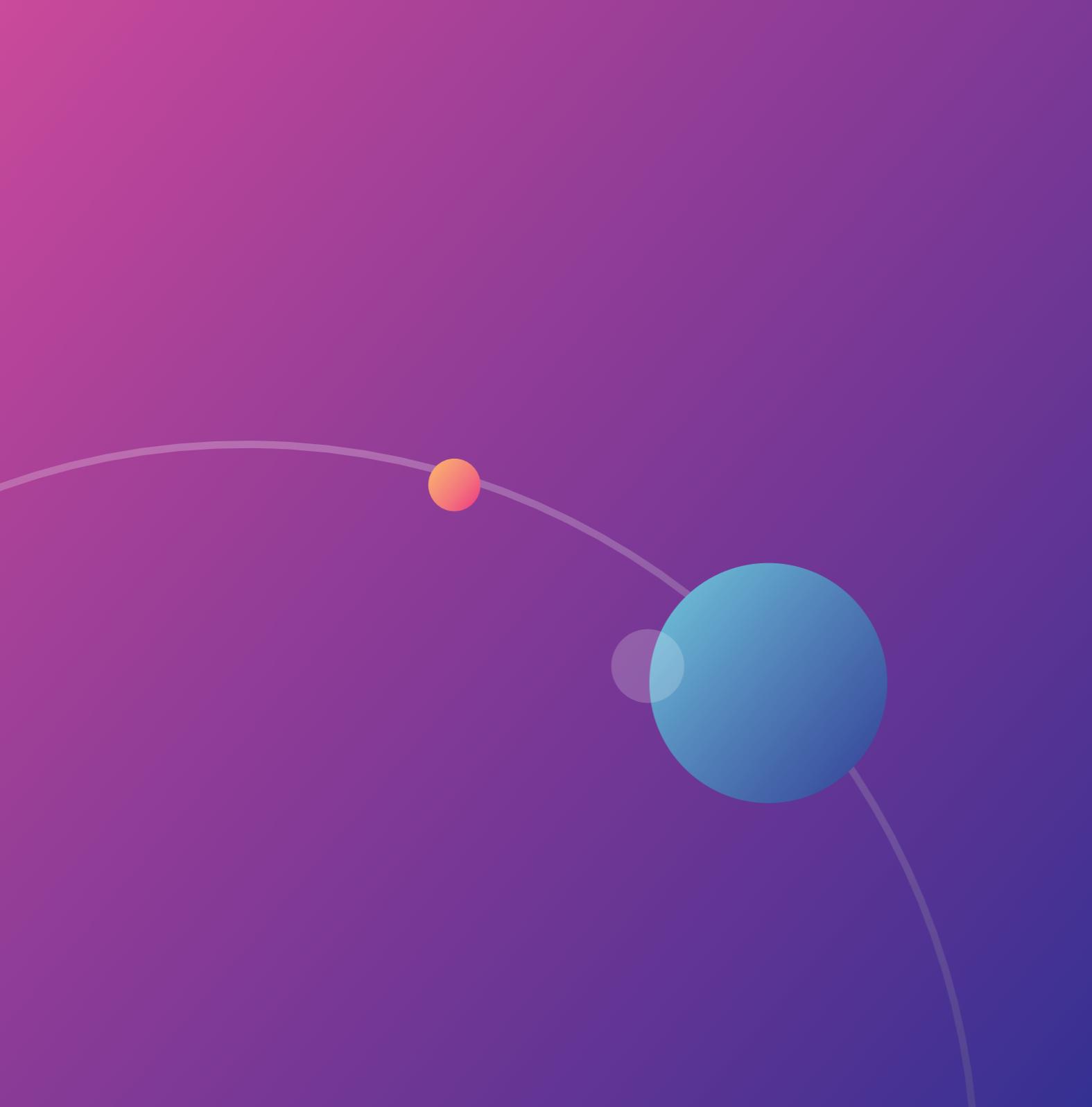


2020
BITMOVIN
VIDEO
DEVELOPER
REPORT



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The Annual Bitmovin Video Developer Report is one of the many resources that we are pleased to present which has become an industry standard for video streaming. Tradition is that we reveal the results in person at IBC. However, in these unprecedented times, with our fourth installment, a printed or digital version and a virtual presentation will have to do.

Welcome

What a year 2020 has been so far! I believe it's fair to say that we've all been feeling the strain of trying to adjust to and master "the new normal." Despite the many uncertainties 2020 has brought, one thing remains consistent and that's Bitmovin's commitment to provide you with comprehensive content offerings that feature the state of the video streaming industry; evolving trends; and what challenges video developers deal with daily, amidst increased costs and competition, to drive the industry forward toward greater innovation.

Participation in the 2020 Report increased 46% from 2019 with a record breaking 792 respondents – twice as many participants as our first Report in 2017! We believe this also reflects the industry growth and important role video streaming plays today.

Thank you to all who participated this year. We are grateful for your feedback and contributions. Without you, it would not be possible to successively create such a thorough picture of the industry.

Stay healthy,
Stefan Lederer
CEO, Bitmovin

KEY FINDINGS

Operational Optimization

- Controlling costs, reducing costs, cost cutting – it is a clear trend and a challenge as over 51% of the participants indicated.
- Subscription-based business model (SVOD 56% +/- 0): In 2019 40% of participants reported they were not using any kind of content protection systems. In 2020, this decreased significantly to 26% underscoring the importance of protecting content.
- Advertising-based business model (AVOD 41% - 7%): A role reversal between Server-Side Ad Insertion (SSAI) and client side ad insertion(CSAI) happened in 2020. SSAI has taken the lead with a 9% increase to more than half of respondents now using this ad insertion architecture.

Rise in low latency applications

- Among the codecs, H.264/AVC remains the workhorse due to its widespread device support. For the newer and more efficient codecs such as H.265/HEVC, VP9, and AV1 browser and device makers are fragmented in their support and adoption rates are low.
- Developers are recognizing the growth of living room OTT devices and are ready to deliver high-quality picture and sound experiences to their viewers via premium value added features and premium audio experiences.
- Participants voiced the critical importance of real-time data analytics to the success of video performance with 65% of the participants naming video startup time the number one video performance metric.

Time-to-Market

- Year-over-year, we've seen the same usage pattern with percentages only shifting by +/- 1 to 3 points. We believe the requirements for video developers remain the same: it's not if a device is supported, but when it will be.
- An overwhelming 51% of survey participants use a mix of commercial encoders presumably to avoid complexities instead of going for an in-house solution.
- "Live streaming at scale" is an ongoing topic, and challenge, in the video streaming world. While the discussion often revolves around ultra low-latency solutions employing WebRTC and WebSocket technologies, the traditional HTTP-based streaming protocols are still used for a majority of live streaming use cases – as nearly 60% of participants indicate.
- When it comes to encoding cloud and managed encoding providers are on the rise (combined +9%). Encoding quickly while using best practices give these solutions a boost year after year. While software encoding on premise fell by 6%.
- Commercial solutions for player codebases increased 7% to 50%. We believe this shift represents how video developers are discovering that an open source solution does not come without added costs. Commercial player codebases further enable faster player releases focused on core unique features with less in-house resources spent on reinventing the wheel.

Methodology

For the fourth consecutive year, Bitmovin has conducted our Annual Video Developer Report between June 29 – August 9, 2020. The number of participants in the report and countries represented similarly reflect this global surge in demand for streaming. Bitmovin surveyed a sample set of 792 video developers and industry experts from 87 countries – participation was up dramatically by 46% from 2019! Consistent with years past, demographics such as industry, company size, and job titles were predominantly in three key industry categories: broadcasters, integrators, and OTT streaming services.

JOB TITLE

Over two-thirds of the participants hold technical roles, such as developers, solution architects, and product managers; 20% have business roles and 4% research responsibilities.

The Bitmovin Annual Video Developer Report is designed to provide an aggregate total of responses with key points and relevant commentary to the developer audience. Several questions are multiple-choice with multiple answers, and therefore may not add up to 100%, and may skew toward certain regions.

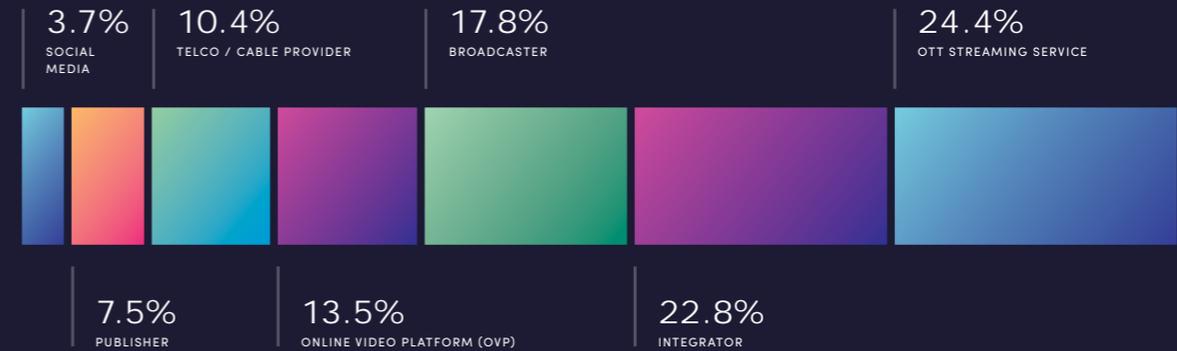
COMPANY SIZE

Approximately 40% of participants work at small companies with 1-50 people; 40% work for large entities with over 300 employees.

JOB TITLE



INDUSTRY



The State of the Streaming Industry

As we delve into the state of the streaming industry in 2020, Bitmovin recognizes this year has ushered in an unparalleled number of challenges and unique opportunities for all businesses. We've added new questions to the Annual Video Developer Report to reflect the issues that developers currently face; what impact COVID-19 has had; the biggest challenges they're focused on solving; and the most promising areas for innovation in this space. The answers will provide you with a broader understanding of where the streaming industry is currently and what are the overarching areas of opportunity.

Part I will be a deeper dive into the more intricate details of the technologies powering video workflows. Part II offers business insights into monetization models and video analytics.

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

When developers were asked what are the biggest challenges they face, we did not expect to see cost control top the charts. No longer is complex technology such as 'live low latency,' last year's number one, what keeps video developers up at night. Despite the majority of participants holding technical roles, over 51% of respondents indicated that cost control for such things as bandwidth and storage is their biggest challenge.

Since our 2019 Report, countless new streaming services have launched worldwide. Headlines dominate the media about which companies will win the streaming wars. Will those that best balance cost and quality with innovation become the long-term winners?

CONTROLLING COST (E.G. BANDWIDTH USAGE)

51%

LIVE LOW LATENCY

45%

STREAM QUALITY

43%

QUALITY OF SERVICE (QoS)

37%

DIGITAL RIGHT MANAGEMENT (DRM)

36%

ADS IN GENERAL

35%

PLATFORM FRAGMENTATION

35%

VIEWER ENGAGEMENT WITH VIDEO

33%



Which of your business and technology priorities have changed due to Covid-19?

The COVID-19 pandemic and shelter-in-place requirements have accelerated global growth opportunities for the video streaming industry. They've also shifted priorities for many developers in this space. As widely reported, numbers of viewers streaming video, and their viewing hours have skyrocketed since the onset of the pandemic.

Coincidentally, the streaming video vendor landscape is becoming increasingly crowded with competitive new services. New offerings such as Apple+, Disney+, HBO Max, and Peacock now join market leader Netflix to compete for eyeballs. Nearly all of the top streaming services are subscription-based with unlimited viewing.

Since the pandemic began, the increase in viewing hours definitely indicates the industry is booming. However, at the same time, and given the uncertainty of the entire global landscape, companies are cautiously scaling back on new projects to control costs.

As a result, it makes sense that reducing costs and time-to-market for services and assets are the top areas of focus to be competitive in this new normal. With over 30% of participants citing changing business models as their third highest priority due to the impact of COVID-19, it still remains to be seen whether intensified competition in this hotly contested market may also lead to new business and pricing models. We suspect our 2021 Annual Video Developers Report may reflect these future changes.

When asked openly about how COVID-19 has impacted their businesses, we received the highest number of answers. For many, COVID-19 has impacted content distribution and shifted focus away from live events and sporting engagements. Navigating the challenges of working from home, distributed workforces, and remote workflows were specified as hurdles. Lastly, it's interesting to note that there was a fair number of participants who let us know that surprisingly, COVID-19 has not impacted their work.

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

As history has shown in past perilous times, challenges often present new opportunities that drive innovation. Many streaming media industry innovations were already in progress prior to COVID-19. The pandemic has helped accelerate the speed of market delivery and the adoption of several innovative new solutions.

Mastering live streaming at scale has always proved most difficult. Even with fewer live events and sports engagements currently happening, it's encouraging to see live streaming continue to top the list as the number one area of opportunity for innovation.

The complexities surrounding viewer engagement also represent new opportunities for developers. Given the increasing number of viewers and various ways they rely on streaming services to be engaged, it will be interesting to see the new ways that developers and providers create to entertain and engage their audiences.

LIVE STREAMING AT SCALE

44%

VIEWER ENGAGEMENT

43%

MEDIA DELIVERY

38%

DISTRIBUTION

37%

CONTENT RECOMMENDATION

30%

CONTENT PRODUCTION

28%

CONTENT PREPARATION

24%

CONSUMPTION

18%

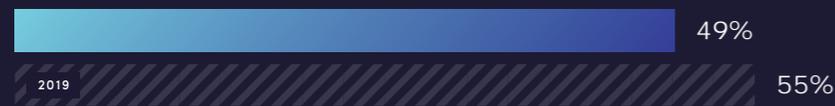
OTHER

4%

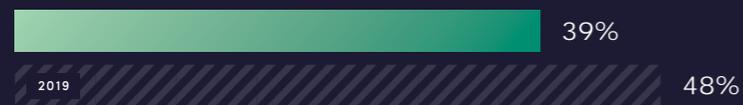
Video Workflows

What would the Bitmovin Annual Video Developer Report be without looking at the codecs and formats the industry has to offer? More importantly, how widely these are being used. An efficient codec and multi-codec adoption may be the competitive edge when balancing cost and quality.

SOFTWARE ENCODER (ON-PREMISE)



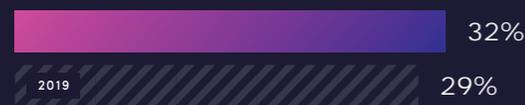
HARDWARE ENCODER



SOFTWARE ENCODER - CLOUD



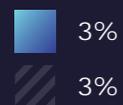
CLOUD ENCODING SERVICE



MANAGED ON-PREMISE ENCODING SERVICE



OTHER

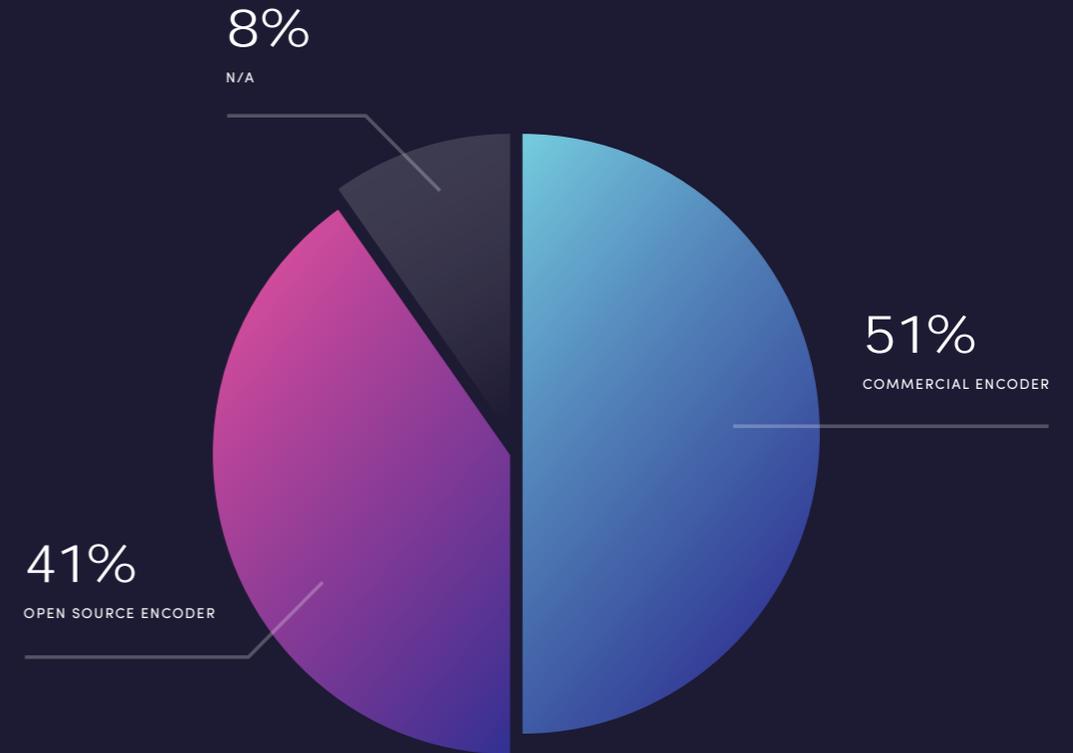


Where do you encode video?

While dipping a mere 6% in 2020, software encoding on premise remains the top location for encoding video.

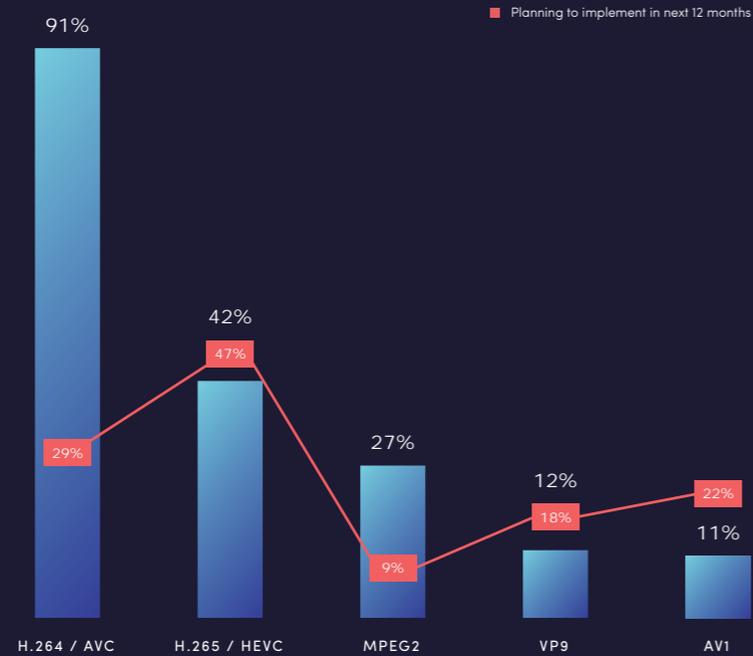
Consistent with previous years, cloud-based encoding implementations are increasing slightly. In 2020, cloud encoding is up 3% to 32% from 2019.

Contrary to last year where we saw an increase by 5%, hardware encoders recorded the largest drop by 9%. Time will tell if this is a result of fewer live events being held or the cost efficiencies and other advantages of cloud encoding services.



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

For the first time, we asked video developers about the types of encoders they use: commercial or open source. An overwhelming 51% use a mix of commercial encoders while ffmpeg was named the encoder of choice for open source. It will be interesting to see if the needle points stronger in one or the other direction over the next few years.

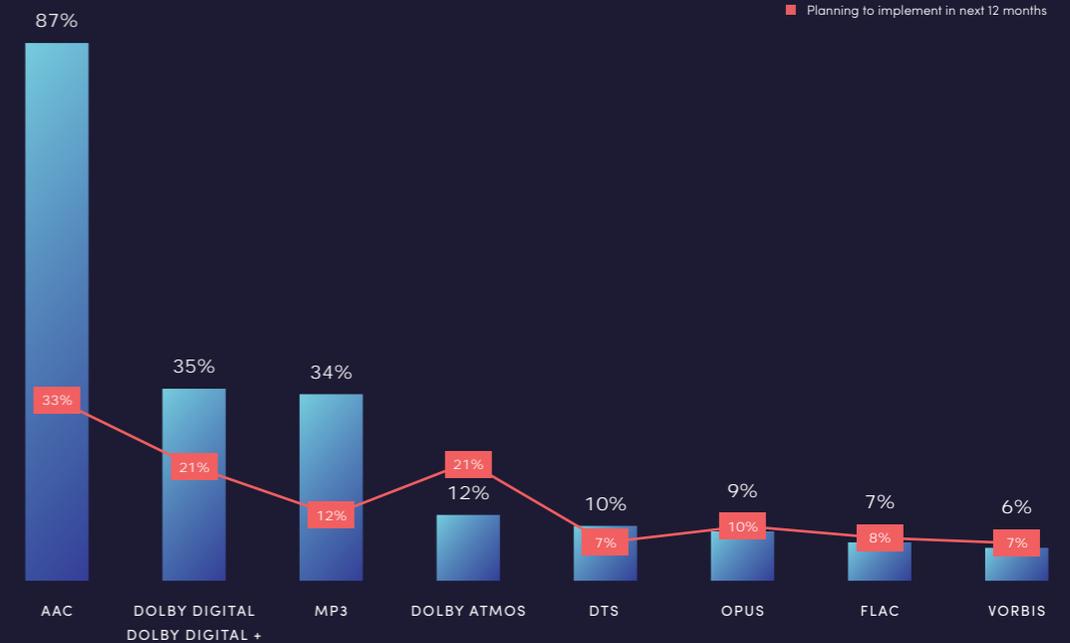


Which video codecs are you using?

Business goals will continue to drive the use of a diverse array of media codecs. While multi-codec usage is reality, most developers and organizations will take a pragmatic approach to adopt and support new media codecs depending upon their business criteria. Target audience, targeted devices and platforms, and support for 4K/8K contents are common objectives among participants surveyed.

Among the codecs, H.264/AVC remains the workhorse due to its widespread device support. For the newer and more efficient codecs such as H.265/HEVC, VP9, and AV1 browser and device makers are fragmented in their support. Apple's Safari browser supports HEVC/H.265, but not VP9. Google and Firefox are behind VP9 and AV1, but not HEVC/H.265.

Report participants let us know that the H.266/VVC codec finalized in June 2020 is already being considered for implementation in video workflows. H.266/VVC will be added to the list of codecs in our 2021 Report.

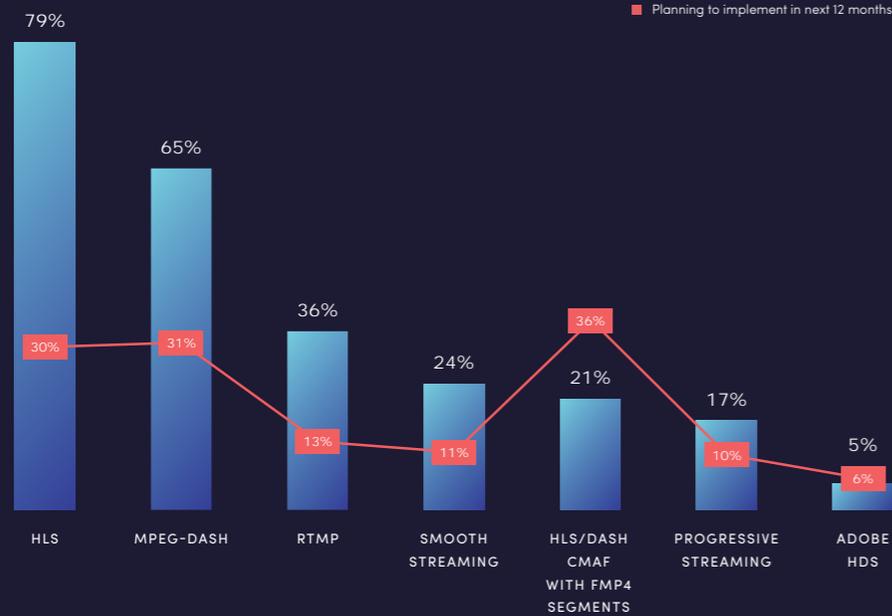


Which audio codecs are you using?

There were no changes to the use of particular audio codecs from the 2019 Report to 2020. AAC continues to dominate the audio codec space as it pursues its promise to be the successor of the MP3 format with its higher sound quality than MP3 at the same bitrate.

Sound quality continues to prove important for elevated viewing experiences. Hence, the use of Dolby Atmos immersive sound technology which has been broadly embraced by artists, content creators, and developers alike; and is trending for future widespread use.

With most movie theaters closed or slowly re-opening due to the COVID-19 pandemic, and movie releases going straight to on-demand, living room and large screen viewing experiences are becoming state-of-the-art and creating increased demand for innovation.



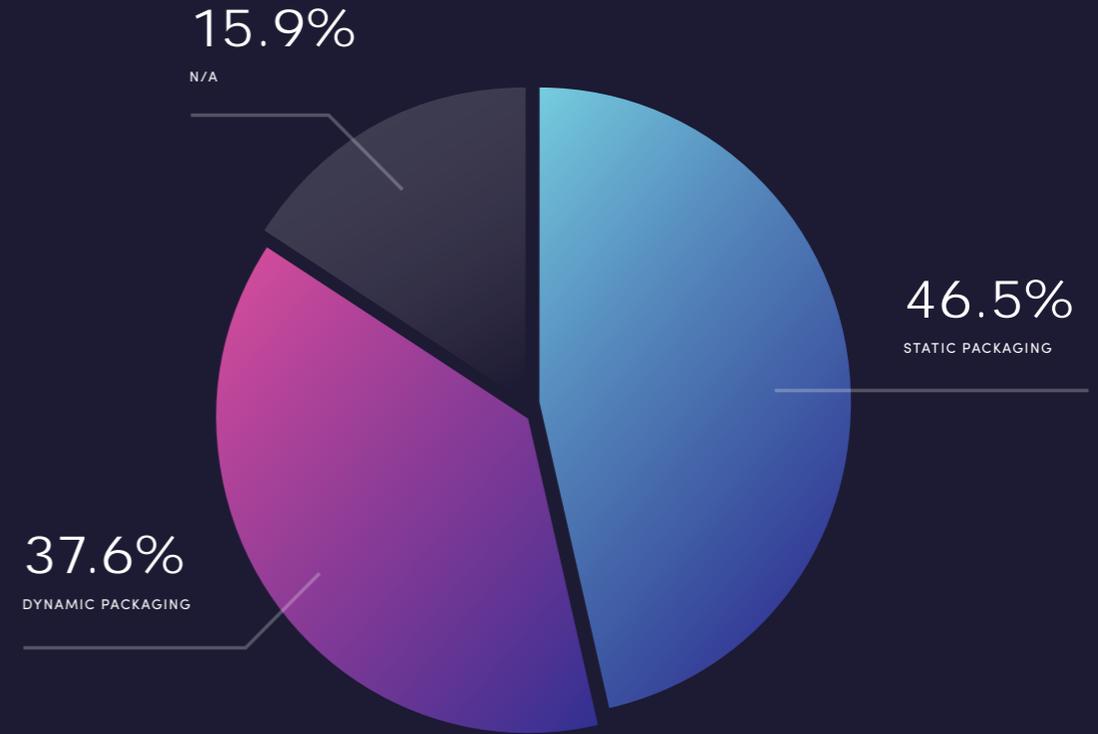
Which streaming formats are you using?

Similar to our 2019 Annual Video Developer’s Report, the year over year data shows only incremental shifts in the adoption of new streaming formats in 2020.

Apple’s HTTP Live Streaming (HLS) remains the frontrunner format closely followed by MPEG-DASH. Survey participants seem eager to get rid of needing two separate formats to serve the majority of devices, pinning their hopes instead on HLS/DASH CMAF with fMP4 streaming as a combined delivery format

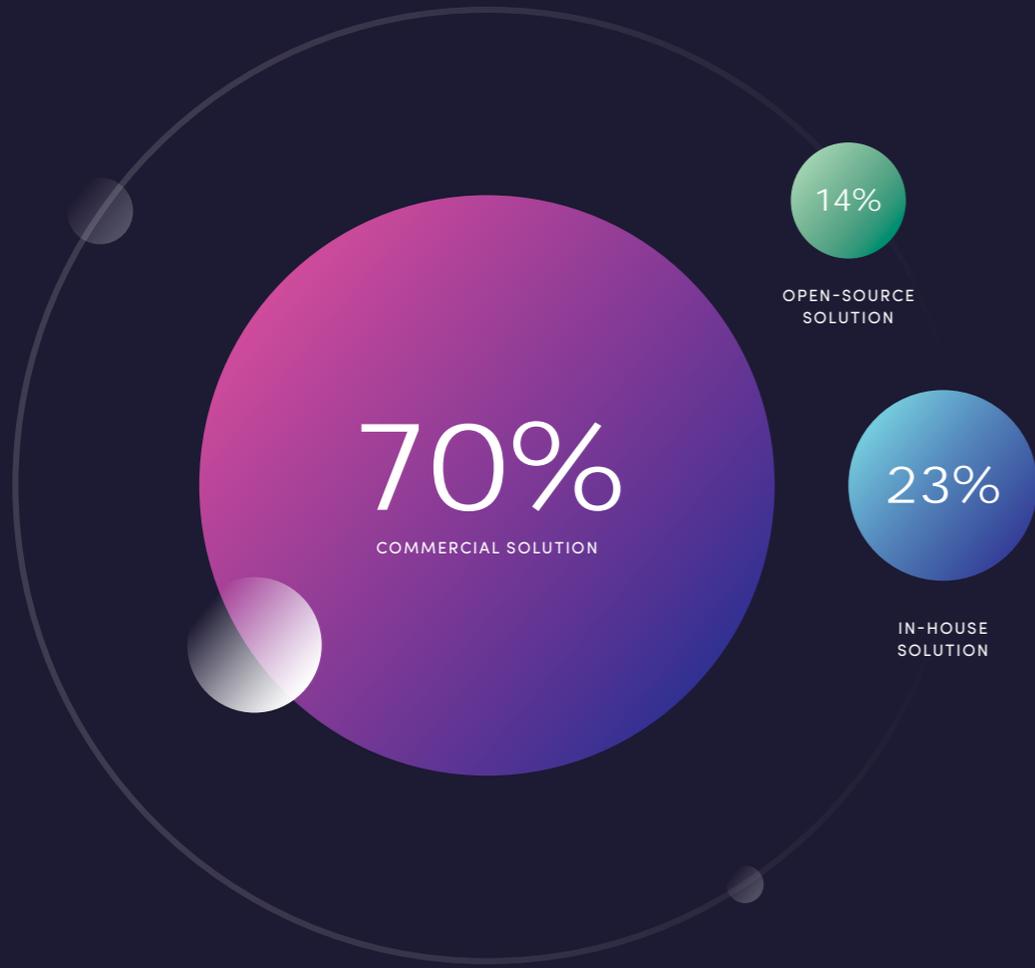
utopia. We’re curious to see if the respondent’s optimistic plans for migrating quickly to HLS/DASH CMAF will pan out over the next year. Meanwhile, progressive delivery continues to decrease while Adobe’s HTTP Dynamic Streaming (HDS) legacy format refuses to die with approximately 5% remaining.

We anticipate 2021 will reveal whether the trendline shows the proper direction for CMAF to close the gap to smooth streaming or if we’re stuck in a multi-format delivery dystopia for years to come.



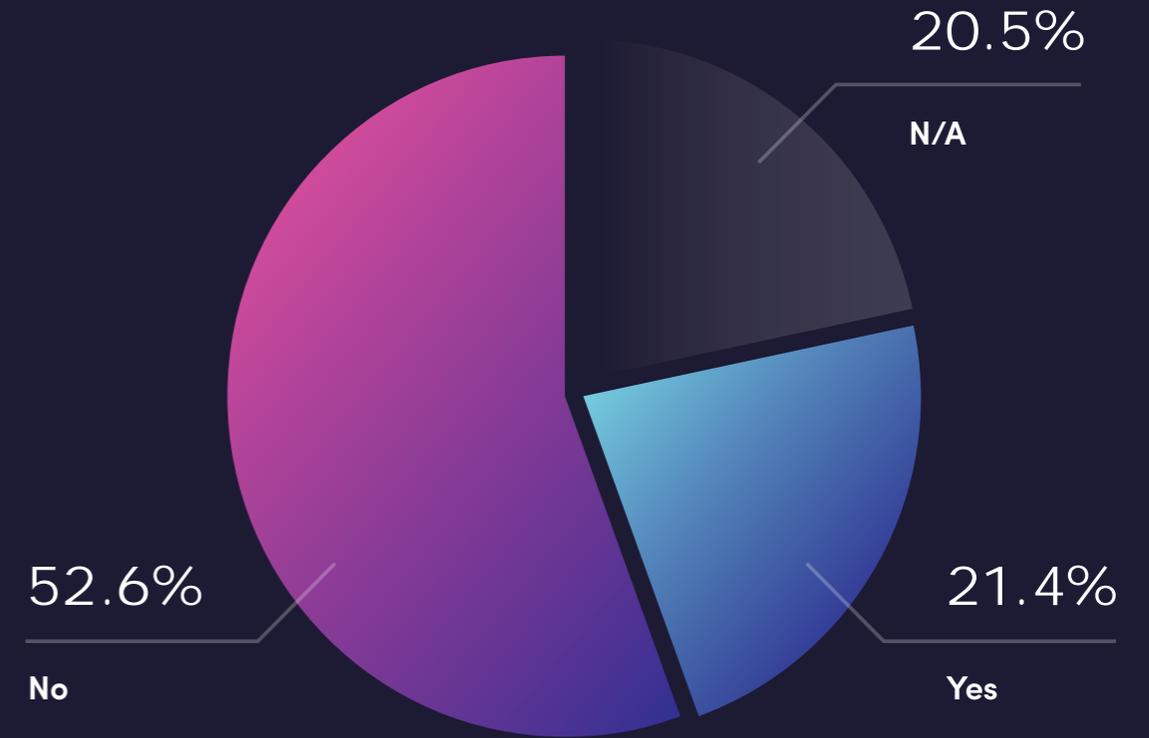
Are you using static or dynamic “just-in-time” packaging?

A first-time question in the report is about one of the most important aspects of the video content workflow: packaging. Packaging performs a key link between transcoding and encryption. Static packaging leads the pack with its advantageous start-up time. A ‘just-in-time’ packager can add time to requests compared to static content.



Which CDN solution are you using?

Given the complexity, required experience and scale of content delivery networks, when asked what CDN solutions are being used, nearly 70% of participants indicated they are using commercial solutions. An uncontested lead over in-house and open-source solutions.



Are you using Per-Title Encoding?

Per-Title Encoding technology is no longer a research topic but starts to become mainstream. This was evidenced by the over 20% of participants using Per-Title Encoding to gain competitive advantage with its benefits: encoding video at bitrates appropriate to content of the video file;

significant bandwidth savings for streaming services; and quality improvements for VoD content. You don't need to convince us! Bitmovin offers the best Per-Title encoding technology in the market according to an analysis by Jan Ozer.

For which of the following video use-cases do you expect to use Machine Learning (ML)/Artificial Intelligence (AI) to improve the video experience for your viewers?

Bitmovin's 2019 Video Developer Report taught us that over 30% of developers were preparing to use artificial intelligence and machine learning in their video workflows. This year, in our 2020 Report, we wanted to better understand what developers believe will improve with the application of machine learning and artificial intelligence. Recommendations and personalizations top the list.

RECOMMENDATIONS

58%

PERSONALIZATION

50%

TAGGING AND CATEGORIZING VIDEO CONTENT

46%

AUDIO TRANSCRIPTION AND SPEECH-TO-TEXT

43%

QUALITY OF SERVICE (QOS)/QUALITY OF EXPERIENCE (QOE)

38%

PER-TITLE/PER-SCENE ENCODING

31%

OBJECT DETECTION

28%

IDENTIFY SCENE BOUNDARIES

27%

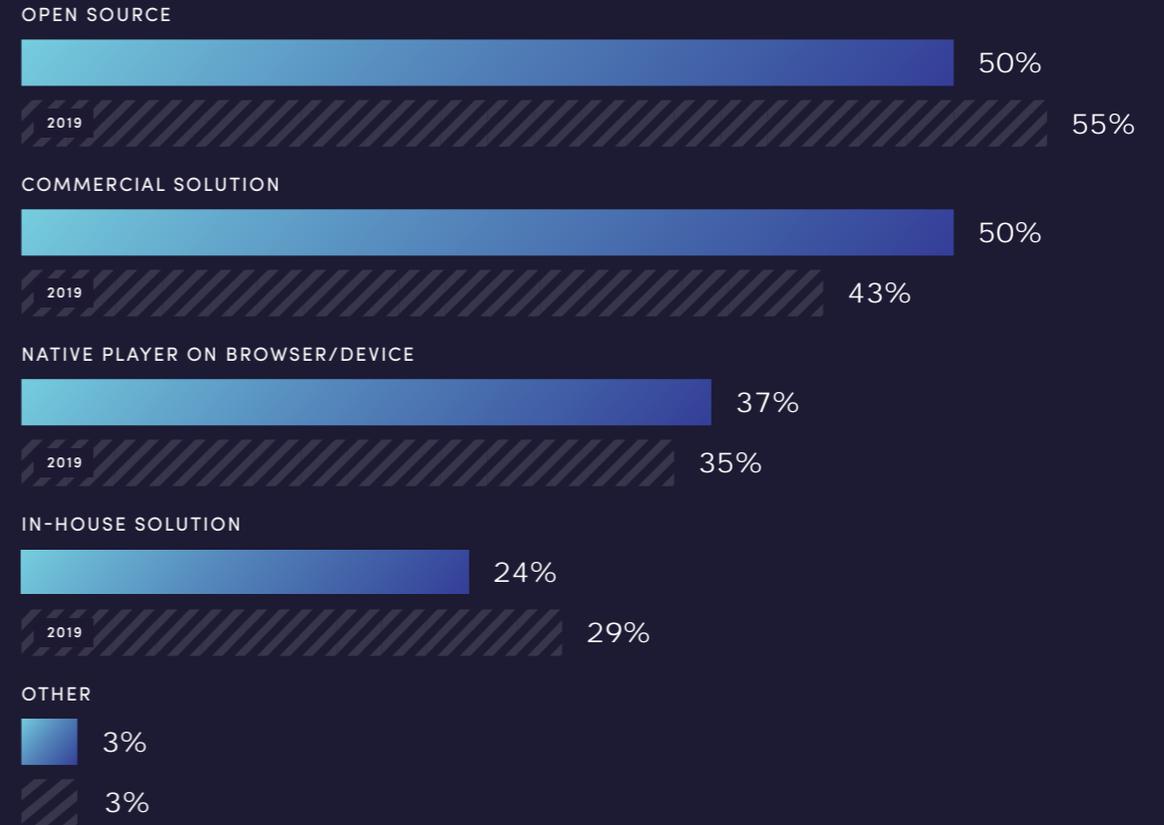
OTHER

3%

Which player code base are you using?

In 2019, 55% of developers used open source for player development. In 2020, that number dropped 5% to 50% while commercial solutions increased 7% from 43% to 50%. We believe this shift represents how video developers are discovering that an open source solution does not come without added costs for consideration such as evaluation, integration, customization and maintenance.

The decline for in-house solutions we saw in 2019 has continued in 2020 as the costs increase for running players that need to play on a multitude of platforms and devices and must integrate content protection and ad delivery as well as subtitles and individual branding, depending on business model.

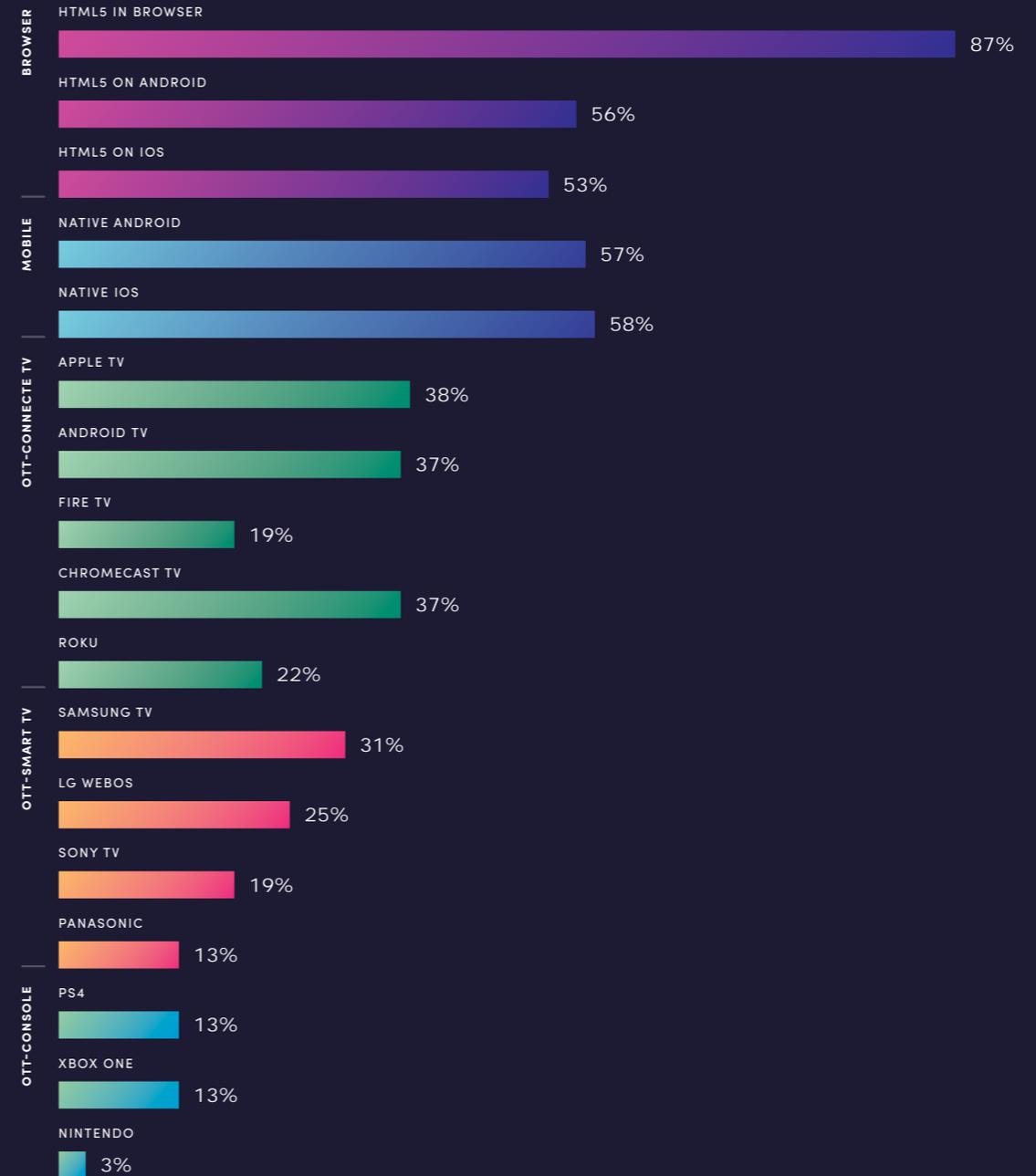


Which of the following platforms and devices do you use to stream video or audio content?

When asked, "Which of the following platforms and devices do you use to stream video or audio content?", responses overwhelmingly demonstrate that we are living in a multi-device world. On average, the typical OTT viewer accesses content on three different devices. With new devices and platforms continuously being introduced, this list will likely be even longer next year.

Year-over-year, we've seen the same usage pattern with percentages only shifting by +/- 1 to 3 points. We believe the requirements for video developers remain the same: it's not if a device is supported, but when it will be.

It's important to note that only 13% of developers are working on PlayStation 4 and Xbox One, and a mere 3% are streaming to Nintendo Switch. This data indicates that game consoles have not yet caught on as streaming devices. However, the longer tail is where there's potential for these numbers to change with the annual fall launches of the PlayStation 5 and the Xbox Series S & X.



BY REGION

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

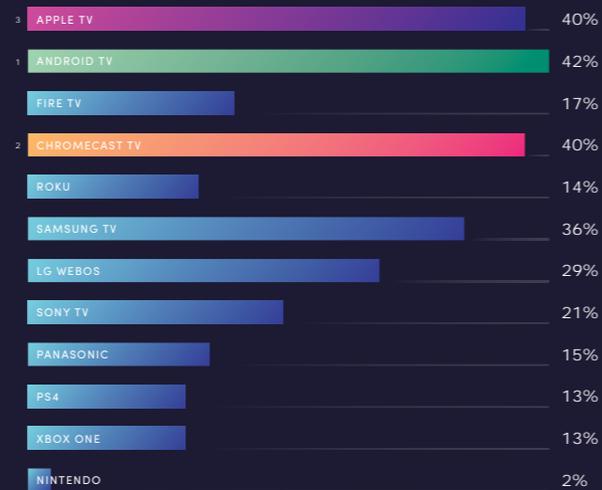
As in 2019, in 2020, Android TV, Apple TV, and Chromecast are dominating the top spots for OTT, regardless of region. This year, we have two outliers: Roku and Samsung TV. Until this year, Roku, had held the top spot in North America – as #1 device to stream audio or video content. AppleTV has taken over as the top streaming device with 37% usage (vs Roku’s 33%).

The Latin American market saw immense growth in consumer usage and developer application, Samsung TV jumping up to the third spot in the region – thus tying AppleTV for 3rd place with 21%.

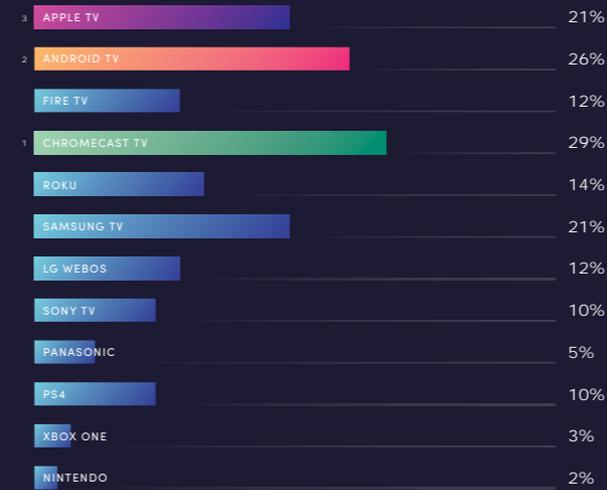
NORAM



EMEA



LATAM



APAC

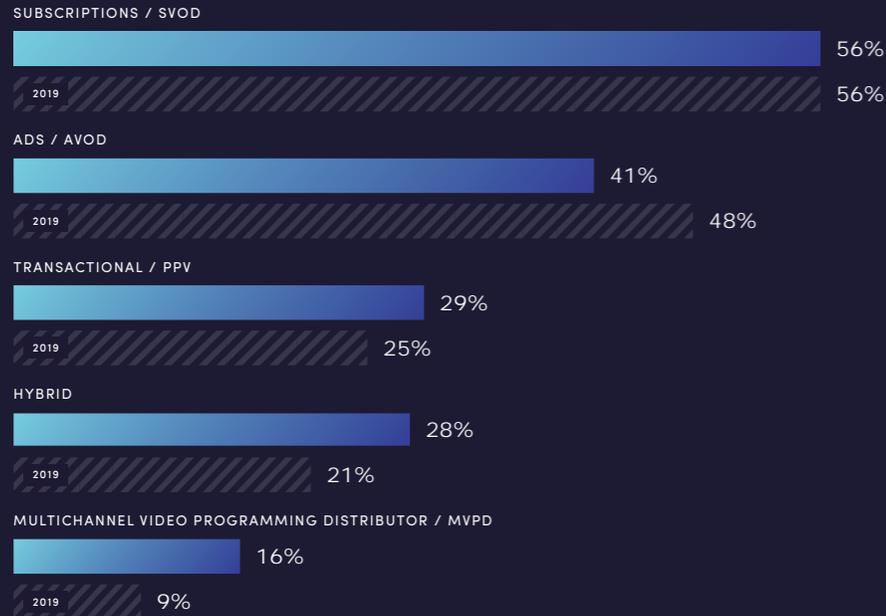


Business insights

A person stands in the center of a dark, cavernous space, illuminated by a bright flashlight beam. The cave walls are rugged and textured, and the sky above is dark with visible stars. The overall atmosphere is mysterious and exploratory.

Business insights are critical to the success of any monetization model in the video streaming industry. With expenses and competition continually on the rise, measurement and analyses must be the focal points in order to achieve operational optimization.

Let's look at the different monetization models and their particular sets of challenges. Plus, an extended section on video analytics. If you don't measure it, you cannot optimize it.

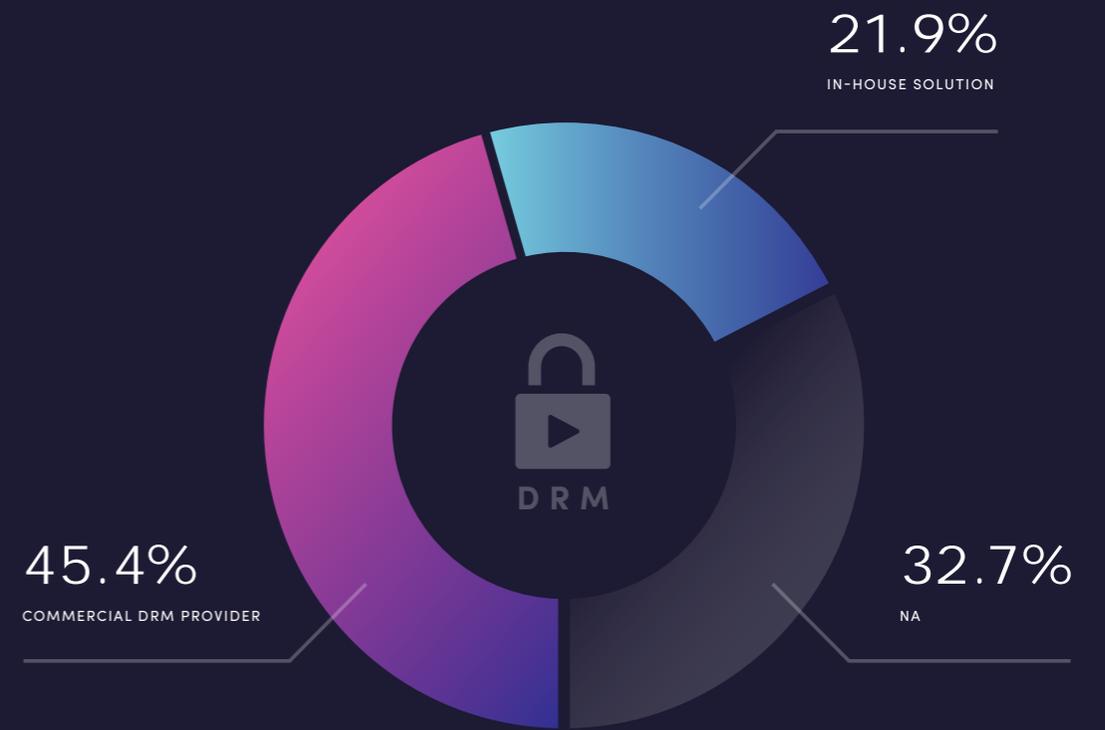


What monetization model do you follow?

As in previous years, the subscription-based model (SVOD) remains the most popular way to monetize, with 56% of participants using this model. Both the hybrid monetization model and multichannel video programming distributors gained popularity with increases of 7% and 5% respectively. Surprisingly, the advertising-based model (AVOD) declined 7%.

According to e-marketer, ad-supported video-on-demand (AVOD) platforms experienced strong growth from ad revenues in Q2 2020, making the AVOD space a bright spot in the ad market amid the pandemic which does not correspond with the answers our survey received. Maybe 2021 will give a more consistent picture.

We are seeing trends emerge in monetization models that may shake up the landscape during the next few years. As new SVOD streaming services continue to enter the market and viewer spending habits for subscriptions are being pushed to the limit due to the pandemic, we anticipate seeing more bundling of offerings and competitive pricing.



How are you implementing DRM in your workflow?

When asked about DRM and content protection, over 45% of video developers are using commercial DRM solutions - twice as many as in-house solutions.

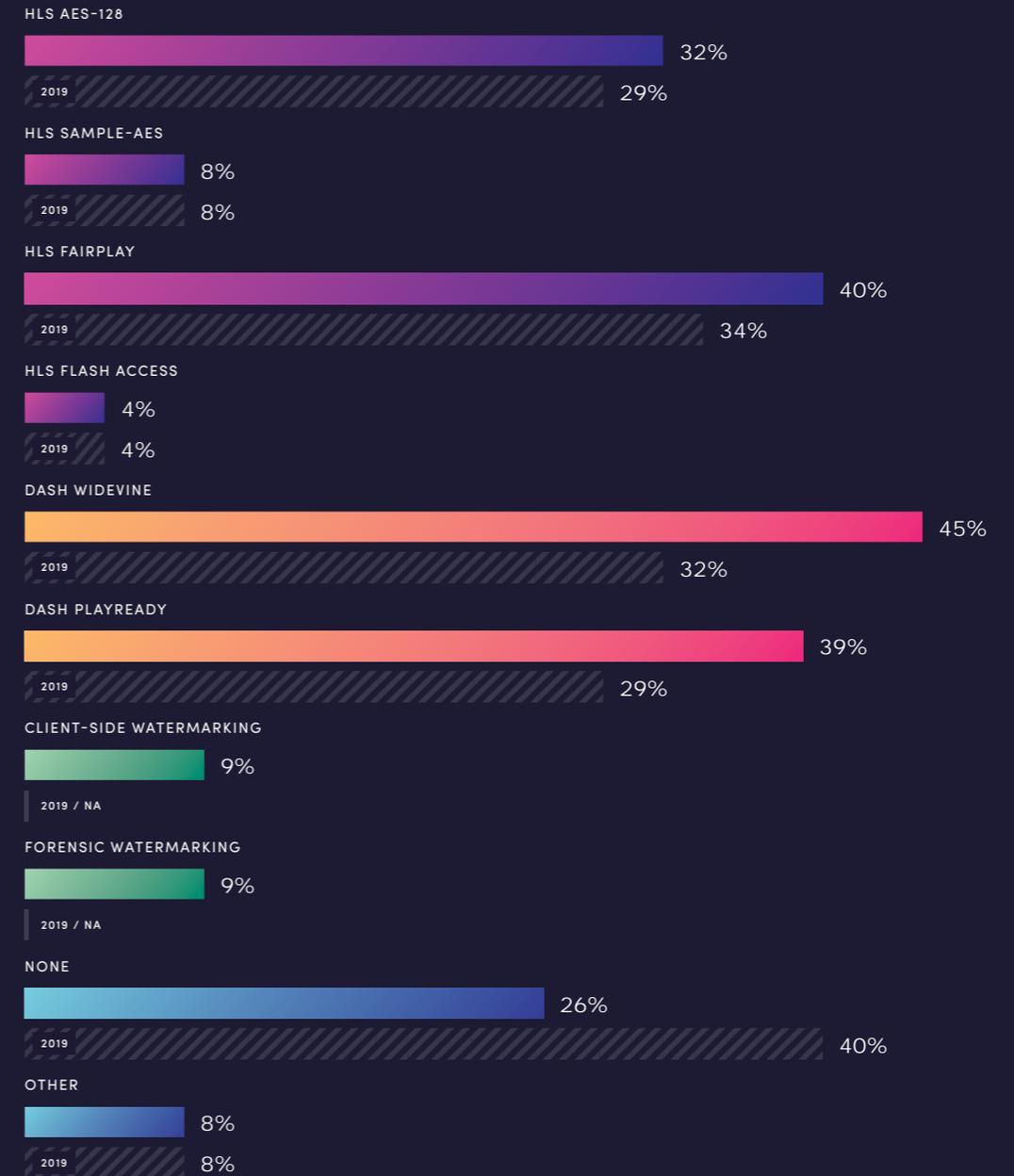
Based on the feedback we received in 2019, this year, we offered the option of "not applicable." And 33% of the participants indicated that content protection does not play a role for them. Protecting premium content, however, is complex with a variety of solutions available. Let's take a look at the kind of content protection that is used.

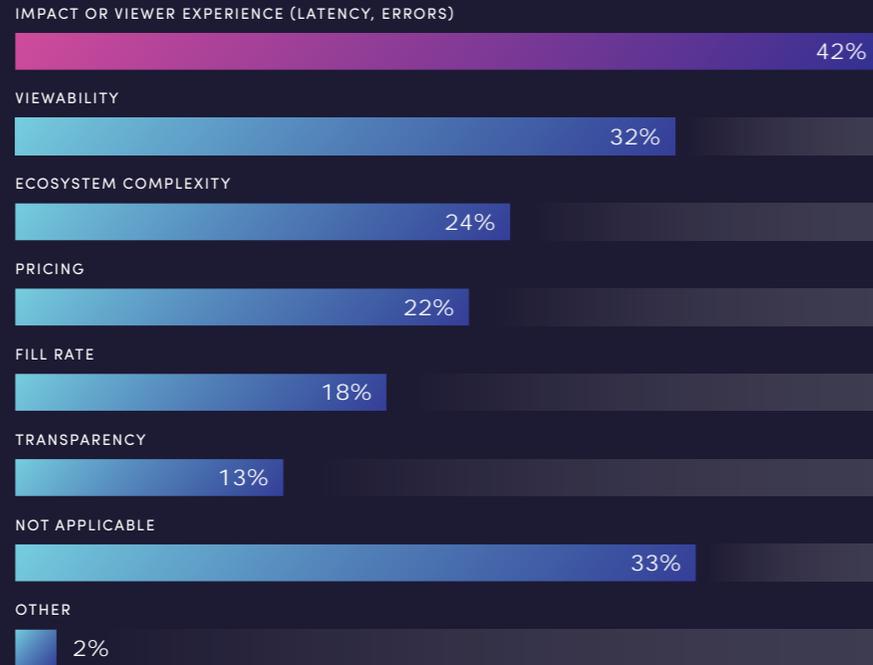
What kind of content protection systems do you use?

Different ecosystems require different kinds of content protection systems. For the Apple environment, HLS Fair Play technology is most commonly used to encrypt content and protect playback on iOS, tvOS, and macOS. The equivalent technology used for the wide range of devices under the Google and Roku umbrella is DASH Widevine.

This year, we added client-side and forensic watermarking as options for content protection. Both appear to be gaining traction with 9% of video developers reporting using these systems.

What's most notable is 40% participants in 2019 reported they were not using any kind of content protection systems. In 2020, this decreased significantly to 26% underscoring the importance of protecting content and prohibiting piracy.



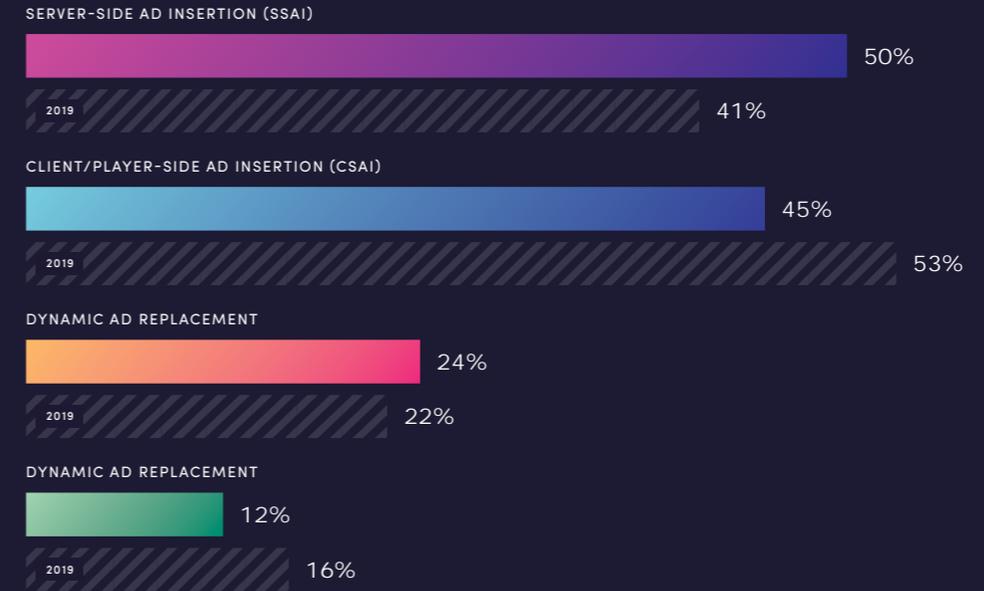


When running ads, what areas are you most concerned about?

In order to get a broader pulse on digital video advertising in 2020, we added a question that perfectly reflects what we are seeing as the biggest challenges for streaming video developers. Of particular issue is the impact that placing ads before or in between content has on viewer experience and the ability to negatively affect viewing habits.

Viewability is a very specific challenge for video advertising that measures whether an ad has a chance to be seen by the viewer. A video ad is counted as viewable when at least 50% of its area is visible on the screen while the video is playing for at least 2 seconds.

With 24% of respondents agreeing, ecosystem complexity demonstrates the overall challenges of a fragmented device and platform world.



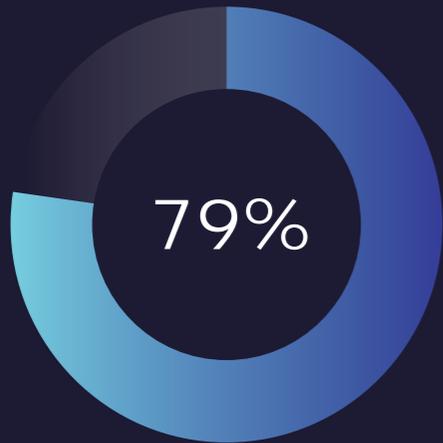
Which ad architecture are you using today?

As revealed throughout the Bitmovin Annual Video Developer Report, there is a lot of consistency with many year over year changes reflected subtly. However, with ad insertion, we see a significant shift and role reversal between server side ad insertion (SSAI) and client side ad insertion (CSAI). In 2019, CSAI was the dominant ad architecture with over 53% usage by Report participants. In 2020, that number declined 12% to 45%

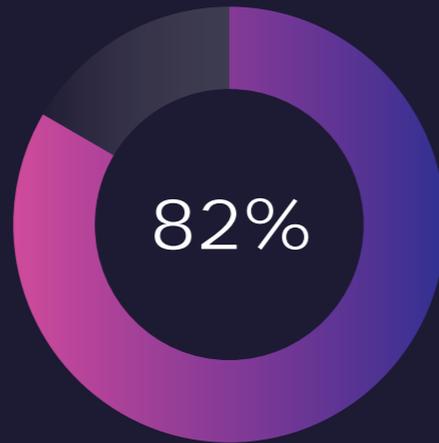
usage. SSAI has taken the lead with a 9% increase to more than half of respondents now using this ad insertion architecture.

We believe this represents the complexities associated with viewability and challenges presented by ad blockers, a particularly big concern as seen in the previous question. SSAI delivers video ads and content as a single stream to the viewers' devices. With SSAI, measurement of ad delivery can be confirmed and verified without being pre-cached; and ads are dynamically refreshed. However, challenges still remain for SSAI delivery, especially with regard to live content delivery.

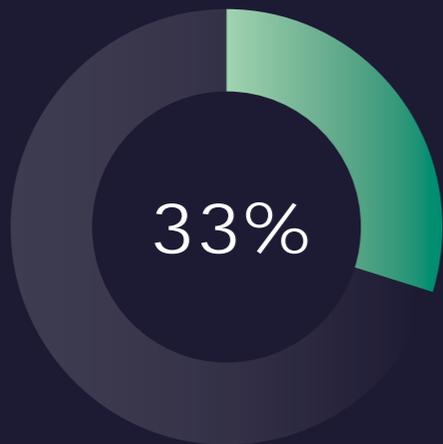
What type of streams do you run?



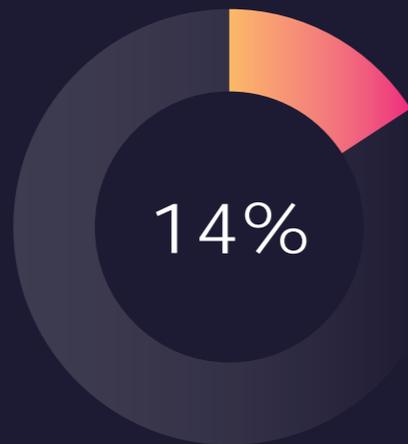
LIVE



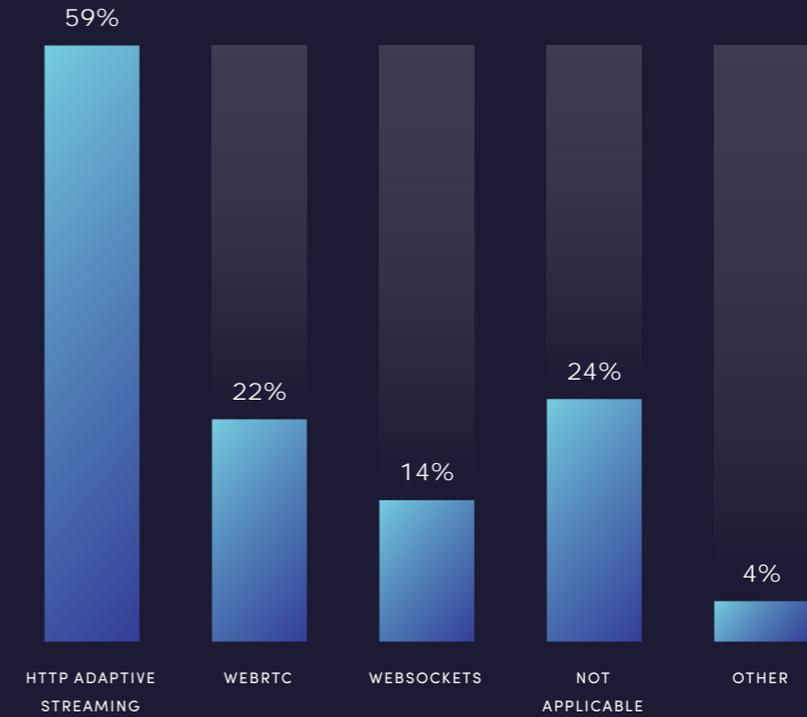
ON-DEMAND



PROFESSIONAL /
PREMIUM CONTENT



USER
GENERATED
CONTENT

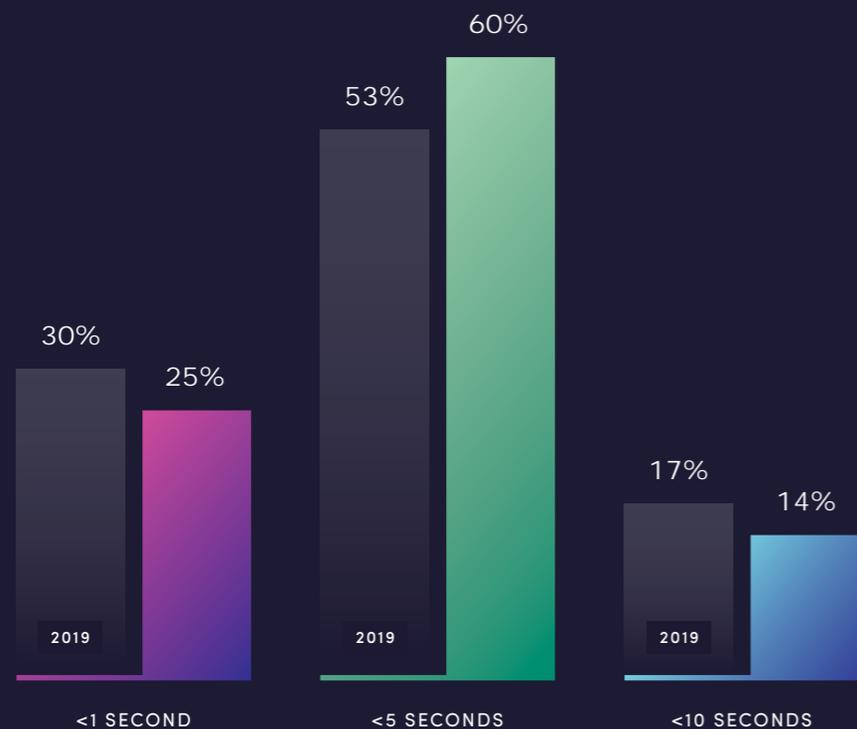


Which technology do you use for low latency?

Live streaming has been an ongoing topic, and challenge, in the video streaming world. While the discussion often revolves around ultra low-latency solutions employing WebRTC and WebSocket technologies, the traditional HTTP-based streaming protocols

are still used for a majority of live streaming use cases--as nearly 60% of participants indicate. It is still difficult to conclude which protocol is best. Depending on the project and devices to which live streams will be distributed, each technology offers pros and cons.

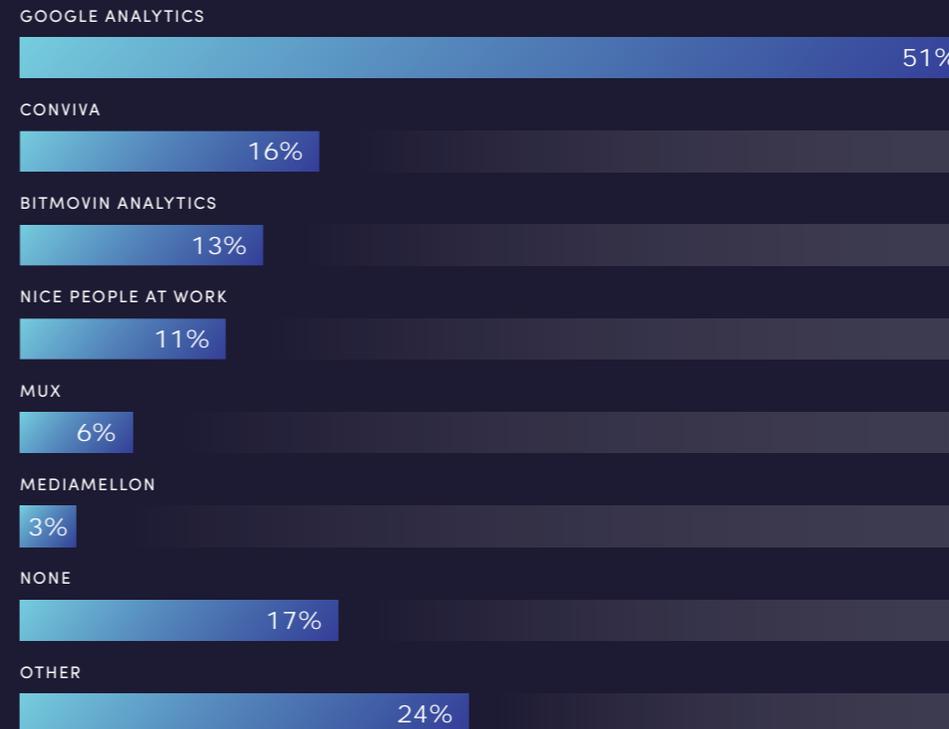
It will be interesting to follow the evolution of live streaming technology. Let's move to the next question to learn more about what video developers deem acceptable for low latency streaming times.



What is your low latency expectation for live streams?

Sixty percent of video developers have a low latency expectation of five seconds or less - up seven percent from 2019.

Nearly 25% of respondents expect one second or less - down 5% this year. In order to achieve a true low latency experience, all parts of the video workflow must play together. This includes encoding, storage, CDN and the player and demonstrates the need for continued innovation in live streaming environments.

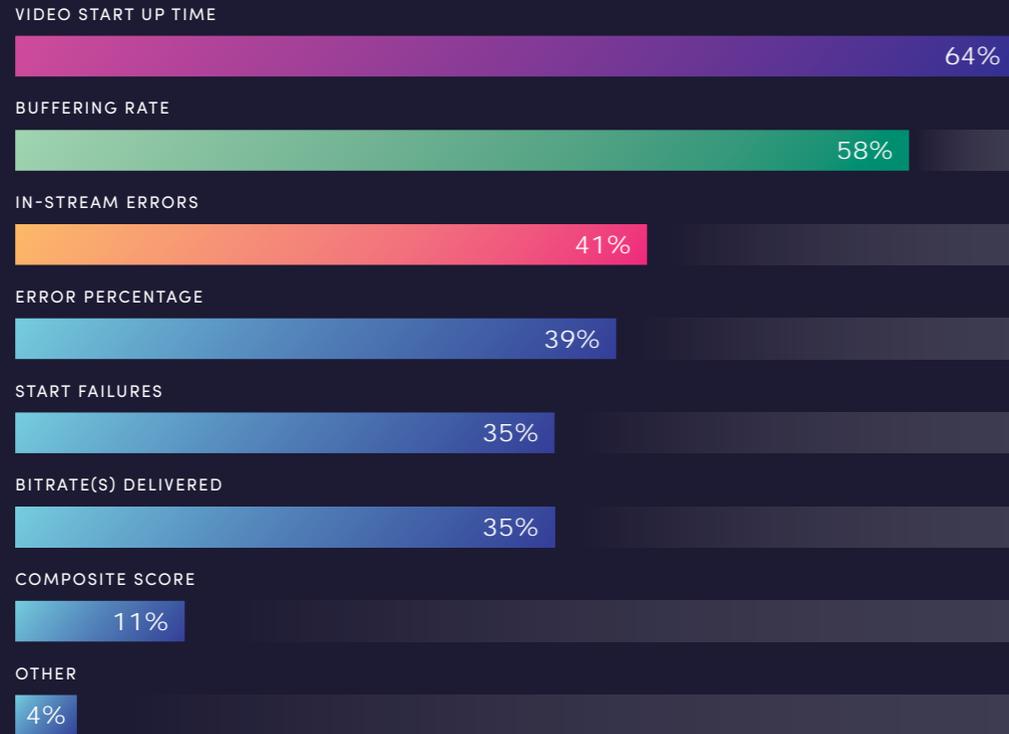


What video analytics provider do you use today?

The most popular video analytic service in Bitmovin's 2020's Annual Video Developer Report is Google Analytics.

We believe this is due to its simplicity and integration with its own marketing and advertising platforms. For more granular data analytics tools and services, Bitmovin Analytics, and Conviva are both gaining market traction.

Participants in the 2020 Report voiced the critical importance of real-time data analytics to the success of video performance.



What video performance metric is most important to you?

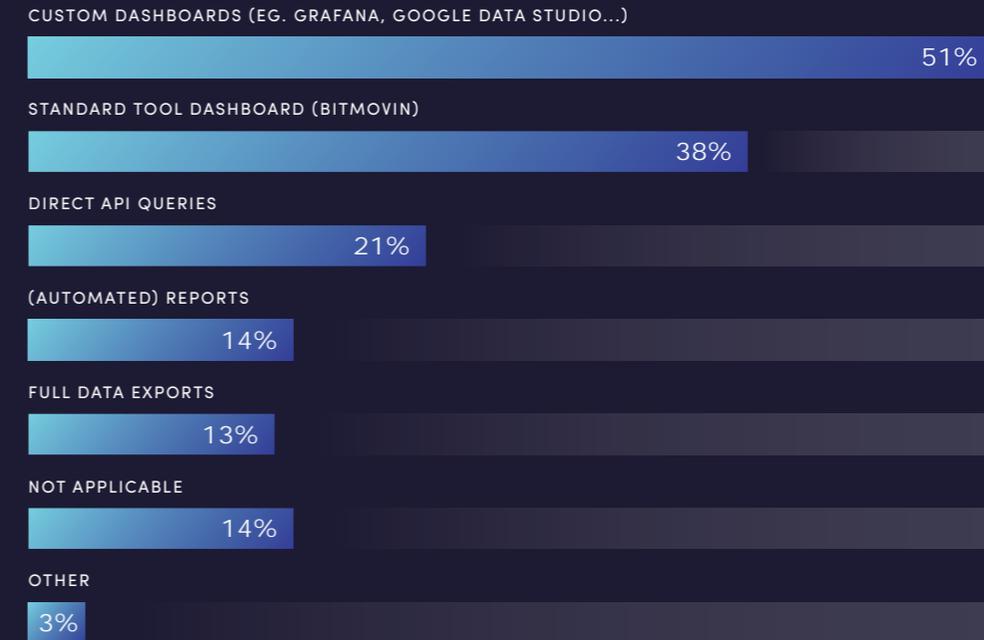
Successful video performance is directly tied to viewer experience. Regardless of the analytics tools developers use, 65% reported

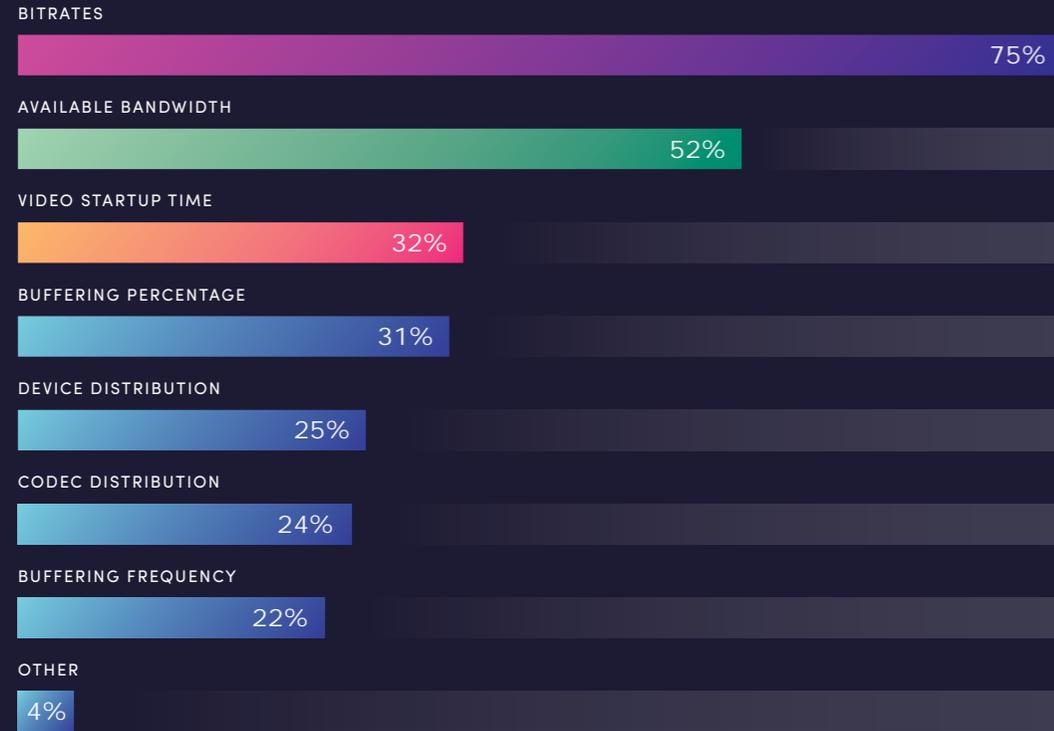
their most important performance metric is video start up time. Two other priorities closely followed with roughly 58% selecting buffering rate and 41% in-stream errors as the most important video performance metrics.

How do you access video analytics data?

Given the importance of data insights into the success of video performance, we believe it's necessary to understand how video developers prefer to access analytics data.

A resounding 51% of respondents prefer solutions that enable them to integrate data into custom dashboards. Clearly, custom dashboards are more valuable and allow for a holistic view. Vendors such as Grafana, Google Data Studio, and Tableaux help make this achievable.

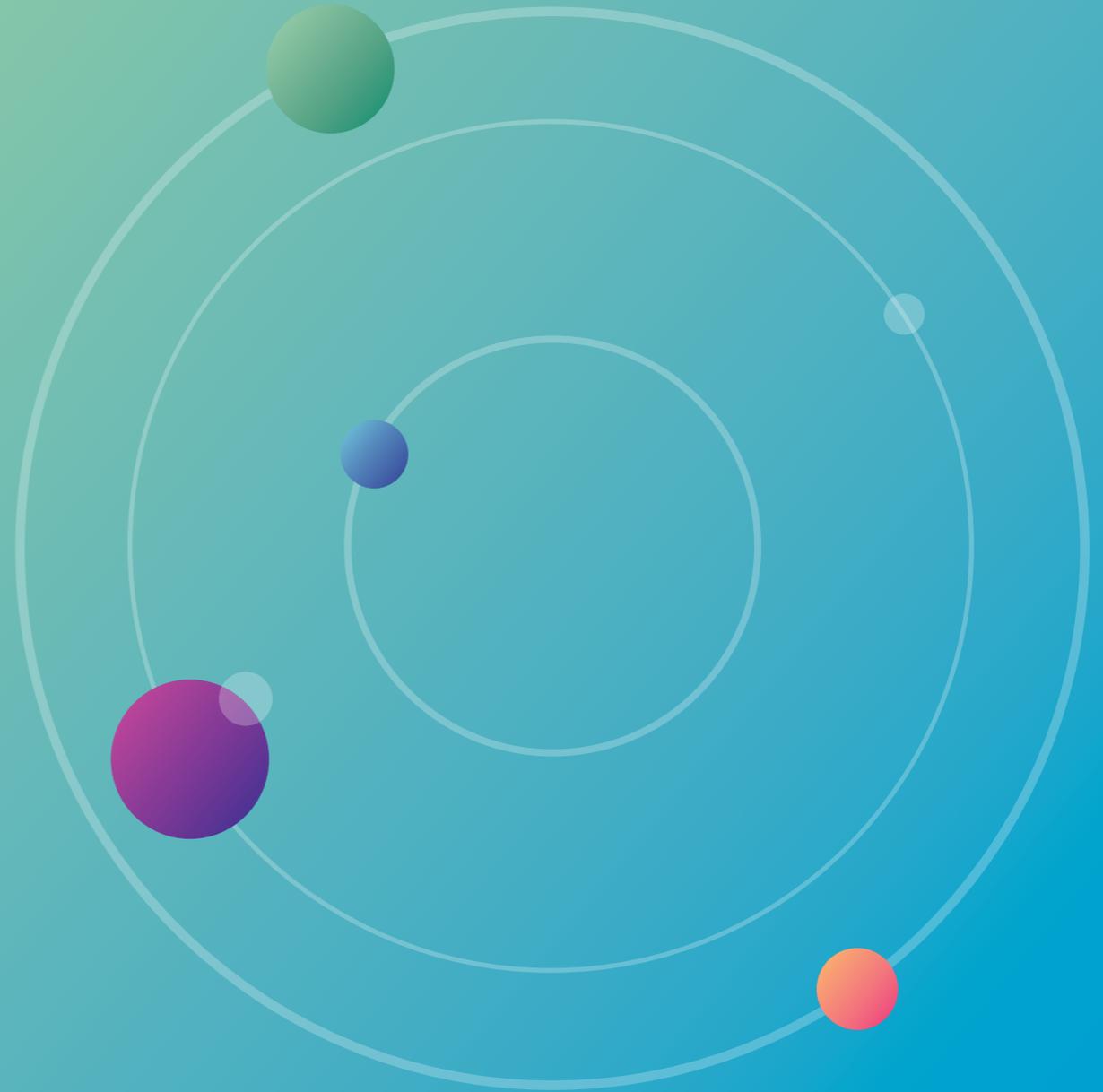




What metrics do you use to optimize your encoding settings?

To close the video workflow loop, we wanted to understand what metrics are used to

optimize encoding settings. Three out of four developers see bitrates as the best angle for optimizing encodings. One of the technologies that enables this is Per-Title-Encoding (see page 25 for adoption of that technology).



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. This is achieved through Bitmovin's unparalleled device reach, flexible integration, and commitment to supporting their customers.

Bitmovin's cloud-native solutions ensure the most flexible and scalable media encoding, playback, and analytics solutions available. Optimize your content

globally using future-proof codecs on the largest number of devices and screens in the market today. Enable teams to customize media workflows to align with rapidly evolving changes in business so they can identify, reduce, and control operational costs quickly. With Bitmovin, be on every screen, every new device, in every market, quicker than the competition can even blink.

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